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GEO. H. FROST, PROPRIETOR.

SATURDAY, JULY 9, 1881.

THE terrible tragedy of one week ago to-day, by which the life of our popular Chief Executive was in an instant of time brought very near to a close, and which plunged the entire nation into an agony of suspense—not yet removed—has been the all-absorbing theme ever since, and the frequent bulletins which we have read each time we went upon the street, and the daily intelligence of our city papers, have filled the columns of all our exchanges to the exclusion of other news. It has been a week of great anxiety to the whole country, and we join in the universal congratulations upon the happy prospect of the speedy recovery of the President from the almost successful attempt upon his life.

NEXT week we will publish a series of six large-sized pen-and-ink sketches by Mr. D. McN. Stauffer, Engineer in Charge of the Dorchester Tunnel, Boston Improved Sewerage, illustrative of the trip of the American Society of Civil Engineers at Niagara, down the St. Lawrence, at Montreal, Ottawa and Quebec. We announce it this week as we propose to publish only such extra copies as are ordered in advance at ten cents each. We proposed originally to get out a small book of the trip, to be well illustrated, and to serve as a remembrance of the happy event. Mr. Stauffer was to furnish the illustrations. We have, however, decided against a book at present, as the work, to be properly done requires an amount of time and labor that we do not now have at our disposal. While, however, the memory of the trip is fresh in the minds of the excursionists, and their hospitable entertainers, we will give them the benefit of Mr. Stauffer's observations. Orders for extra copies must be received not later than the morning of the 15th inst., as we go to press in the evening.

THE NEW YORK UNDERGROUND RAILWAY.

In ENGINEERING NEWS of Nov. 6, 1880, we described at some length the plans of this company for an underground railroad from the Battery to the Harlem River. As the plans, as then described, have been somewhat changed, we will briefly recapitulate, and add such information as we have been able to obtain up to date.

It is proposed to construct two small parallel single-track tunnels, the clear width of each being twelve feet seven inches, and the height from the top of the rail to the crown of the arch, fifteen feet—sufficient for the passage of a Pullman car. The shape of the tunnel will be vertical sides with two similar three-center arches resting upon a dividing wall. After a firm foundation shall have been secured, a bed of concrete will be laid in which inverts of brick and concrete will be placed to support the walls. At the Battery and Canal street, sheet-piling will be necessary. The piling will consist of two courses of grooved and tongued timbers, nine inches thick—making a total of eighteen inches—driven down by pile drivers. To effectually exclude all water and sand during building, a quick-setting cement will be placed at the top and sides and at all points where leaks appear, and pumps will be used to keep out water which may flow in from beneath.

In order to guard against caving of the sides, especially when the route is through loose material, the sheet-piling will be braced at every ten feet by heavy beams extending from one side to the other. In the centers of these beams cleats will be fastened as rests for horizontal struts extending to the center of the piling, between the ends of the beams—thus making the bracing effectual for every five feet.

Upon the top of the piling will be placed a flooring of heavy planking, and on this a layer of concrete.

Throughout the rest of the distance a bed of sand is encountered, except from Fourteenth street to the upper terminus, which is rock; these will require very little or no artificial foundation.

The walls of the tunnel will vary in thickness according to circumstances, being heavier in treacherous material than in sure. The dividing wall will be three feet thick and large apertures—fitted with doors or iron shutters—will be built at about every twenty or thirty feet.

The entire exterior surface of the tunnel will be coated with a layer of German asphalte from one-half to one inch in thickness, so that it may be absolutely impervious to water. The interior surface will be covered with a hard white finish similar to that used in buildings.

The greater part of the work will be below the gas and water mains, which, while the excavation remains open, will be supported by iron chains at intervals of ten feet.

The line of the proposed tunnel is nearly identical with the ridge or backbone of the city, which divides the system of sewerage into two parts—one emptying into the East River and the other into the North. The plans at the office of the company show the line of road, and the sewers which would be intercepted, with the changes proposed in order to secure effective drainage. Sewers, in which the grade or flow is across the tunnel, will be closed by a wall upon the lower side of the line, and a connection built from the intersection of the other side to a sewer which flows in the opposite direction. The distances which these connecting branches have to be built vary according to the size and location—in some being short and presenting no serious difficulties, while in others it is several hundred yards, and in one instance an entirely new sewer will have to be constructed nearly to the outfall at the river. This work will all be finished before the arrival of the tunnel, in order that the work may not be delayed. According to the plans, about two miles of new sewers will be built—one-half of which would be in Broadway. We were informed by Mr. Walter J. Morris, the Chief Engineer, that the plans had been submitted to Mr. Stevenson Towle, Chief Engineer of Sewers of the Department of Public Works, and the changes approved by him. Sewers of improved construction will be built, and it is expected that the alterations will greatly assist in quickly and effectually removing the sewage of the district passed through.

The grade of the road will conform as nearly as possible with that of the street under which it passes, and in only a few instances will it be more than eight feet below the surface. The greatest depth will occur between Thirty-fourth and Forty-second streets, where it will be about forty feet. The average depth of the top rail below the surface will be about twenty-one feet, and the average depth of the platforms of the stations eighteen feet. The track will be standard gauge, four feet eight and one-half inches, resting upon creosoted ties. Owing to the dry atmosphere and almost uniform temperature, it is expected that these ties will wear two or three times as long as those on the surface. The rails will be laid with touching ends, which will not only save the hurtful battering, but will increase the comfort of the passengers and decrease the wear and tear on the rolling stock.

The cars will be similar in finish to those now in use on the elevated roads of this city, and will be of two kinds—those with doors opening in the sides and those with the doors in the ends. According to present calculations the fare will be five cents, except for the end cars, which as their construction permits of a more comfortable seat the rate will be higher.

As the foundations will be of ample strength, compressed air engines, weighing sixty tons, and drawing trains of from twelve to fourteen cars, according to the amount of travel, will be used.

The stations (detailed drawings of which are at the company's office) will be from three hundred to five hundred feet long, with platforms fourteen feet wide in the center and gradually narrowing toward the ends. Above the platforms the stations will be from fifteen to twenty feet in height, with egress and ingress passage-ways sixteen feet in width.

The stations, cars and tunnel will be lighted with electricity.

In constructing the tunnel a temporary wooden bridge or floor will be thrown across the street, and will be supported upon the curbs at each side and upon columns at the center. This work will be done at night in order that travel may not be impeded. Inclines will be formed on such of the side streets as may be most advantageous for the work, and it is thought fifteen feet will be ample width for two passage ways for teams and materials and one for men. When it becomes necessary to disturb the pavement, as it will be at some of the stations, and when iron beams are laid across the street, wooden bridges will be built so that travel may continue uninterruptedly.

The plans for a system of ventilation have not been changed since our last article and consist of air shafts placed at the stations and along the line. A change of air in the tunnel will be effected by means of a flange projecting from the engine and nearly filling the tunnel.

Mr. Joseph Patterson, of Baltimore, has taken contracts to build sixty-five hundred feet of the road north of the Battery and sixteen hundred and fifty feet south of Leonard street.

The bonds of the road below Fifty-ninth street are restricted to $2,000,000 per mile, and it is expected that the road, equipped and ready for operation, will cost $2,250,000 per mile.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 265.)

XXXI.—TORONTO.

Toronto, in Canada, is on the north shore of Lake Ontario. The site of the city is a plain, sloping gently from the lake shore for about two miles, the ground then rising more abruptly to a range of hills. Settled in 1794, and first called York, it was made the seat of government of Upper Canada in 1799 under its present name.

In 1841, the population being about 20,000, water-works were erected by private enterprise, taking the supply from the lake opposite the city and pumping it by a steam engine, with cylinder of 24-in. diameter and 54-in. stroke, working two single acting pumps of 8-in. bore and 72-in. stroke. A contract was made for supplying the city for 21 years with water for extinguishing fires, but in 1850 the deficiency of supply was complained of. The water was pumped into a stand-pipe and also into two small reservoirs, called the St. George's and Clover Hill reservoirs. In 1851 these works were sold to a company, but soon reverted to the original owner, Mr. Furniss. In 1856-7 a second engine was erected with steam cylinder of 33-in. and pump of 24-in. diameter, both having 72-in. stroke. Up to this time the works had cost about $160,000 and were paying a good dividend. In 1870 a com

* Copyright 1881.

pound engine was erected, with cylinders of 22-in. and 38-in. diameter and 48-in. stroke, working a bucket and plunger-pump of 27¼-in. diameter and 48-in. stroke,

These works were purchased by the city in April, 1873, for $220,000, which included also 20.77 miles of pipe, seven miles of which were of wrought iron and cement, and the rest of cast iron.

The construction of new works was begun by the city in January, 1873, after plans recommended by T. C. Keefer and E. S. Chesbrough, Consulting Engineers, P. Alexander Peterson being the Chief Engineer.

On the outer shore of a sandy island in Lake Ontario, about 7,000 ft. from the wharf line of the city, a basin was excavated 155 ft. from the water's edge, and 2,700 ft. long, and 24 ft. wide at the bottom, which was 13.5 ft. below water level. At the north end an arm was dug, at right angles to the main basin, 390 ft. long and 30 ft. wide at bottom, with slopes of 2 to 1. The rate of filtration of water into this basin from the lake was found by tests made in February and March, 1876, to be about 4,413,000 United States gallons in twenty-four hours, or 1,420 gallons per linear foot of gallery per day, the difference of level between the lake and the gallery being 7.5 ft. The average consumption at that time being about five million United States gallons, the gallery was unequal to the supply, and two cuts were made through the bank into the lake. One was a trench dredged to 12 ft. below water level, 20 ft. wide at bottom, with slopes of 2 to 1 and extended 300 ft. into the lake. The trench was filled with flat stones and small round stone of 6 in. cube (called cable stone in the Eastern part of the United States and boulders in the Western States) to a depth of 6 to 9 ft., and covered with from 12 to 18 in. of gravel, over which the sand of the bank was replaced.

In the other cut a wooden conduit, similar to the one hereinafter described, was laid for 345 ft. into the lake, terminating in a crib 20 ft. square, built of 12 by 12 in. timbers spaced 4 in. apart, and divided into nine compartments, eight of which were filled with stone, the central one being left as a chamber. The wooden pipe led to this, and a length of 50 ft. of perforated pipe extended from the opposite side into the lake. A test made at the completion of these works, showed that 12 million gallons per day could be drawn under a head of 3 in.

In 1878 these channels were twice filled with sand, cutting off the supply, and in February, 1879, they were useless, and a cut was made directly into the lake, in which at first an under box was placed, but on this becoming filled with sand an open cut was tried, which met with the same fate at once, and the attempt was abandoned.

The water from the basin or gallery is of bad quality, being evidently derived from the marsh land on the shore side, and impregnated with vegetable matter. Work is now (1881) in progress by which the water is to be brought from a crib 3,000 feet in the lake, through a wooden conduit.

From the north arm of the filter-basin, a wooden conduit was laid in 1874, for 6,000 ft. across Block House Bay to Gibraltar Point, the northwesterly point of the island. The conduit is of 4 ft. interior diameter, constructed of staves of green oak and pine alternately, each 3 in. thick, 6 in. wide and 16 ft. long, bound with iron hoops, 3 in. wide and 2 ft. apart. At first, 1,400 ft. of this pipe was built continuously, a scow and sloping framework being drawn forward from under it as built, but all of this had to be taken up, as the trench could not be kept clear of sand. It was relaid in sections of 200 ft., with iron flange joints bolted together by divers. Part of the pipe was not properly covered with sand, and in December, 1875, when pumping through it began, portions of it rose to the surface of the water. The pipe was taken up, the trench dredged out and the pipe again put in place and covered with 2½ ft. of sand and has since stood well.

The conduit terminates in a timber crib at Gibraltar Point, whence a submerged 36-in. cast-iron pipe, with Ward's flexible joints, is laid 4,444 ft. to the shore. When the wooden conduit floated, an opening was made in the side of the crib for supplying the city with water. The pipe terminates in a crib sunk 700 ft. from the line of the esplanade along the harbor front of the city, furnished with an inlet pipe to draw water from the bay. From the crib iron pipe leads to the pump well, 200 ft. from the esplanade. Its foundations are carried to rock, which is 6 to 9 ft. below water surface. From this well the water is pumped by two Worthington compound engines, one of five million gallons' capacity, erected in 1874; the other of ten million gallons' capacity, erected in 1876, pumping either into the reservoir or directly into the mains as required.

Rose Hill reservoir is 3.5 miles from the engine house on the ridge north of the city. Its surface of 9½ acres is 216 ft. above the lake, and it contains 40,168,320 U. S. gallons. It is in excavation and embankment, the bottom and slopes covered with 6 in. of broken stone overlaid with 12 in. of gravel. The inlet pipe is laid under the embankment and is turned up with a bell mouth for 2 ft. at the foot of the inner slope. It was laid in puddle with three collars of brick masonry a foot thick and a foot projection. Some slides occurred on the exterior slopes prior to 1878, but they have checked by underdrainage. The reservoir is reported as not leaking.

For the new works cast-iron pipe is used for distribution, and most of the old cement and wrought-iron pipe has been taken up. No pipe of less than 6 in. diameter is now laid. There were 111.29 miles of pipe in use on Jan. 1, 1880.

At that date there were 49 meters in use, 8,563 taps, 47 hydraulic elevators and 1,070 fire hydrants.

The population of the city is about 80,000. The cost of the works was $2,000,000, the cost of maintenance in 1879 was $50,557, and the revenue from water takers, $107,000. The daily consumption in 1870 was 1,500,000, and in 1879 was 4,660,000 U. S. gallons.

The works were built by a special commission, Peter Alexander Peterson being Chief Engineer, and are now in charge of a committee of the Board of Aldermen, Redmond J. Brough being Engineer and Manager.

XXXII.—WORCESTER.

Worcester, Mass., is in the centre of the State, on a branch of the Blackstone River. The country in the vicinity is hilly and the town itself of irregular topography. The stream affords a valuable water power at this point.

The town was settled first in 1675, but the permanent occupation of the site began in 1713. It was incorporated as a town in 1722 and as a city in 1848.

On March 2, 1798 the Legislature authorized Daniel Goulding to conduct water in subterraneous pipes from a spring to the town for supply for the citizens, the authorities being permitted to use the water for fire purposes. In 1845 the Worcester Aqueduct Company was incorporated, which brought water from Bell Pond, 201 ft. above the main street of the city in pipes, the town paying $500 per annum. The population then was 11,556. In 1848 the works were purchased by the city, and in 1851 there were 56 water takers, and the daily consumption 22,000 gallons. The aqueduct at that time was for 280 ft. a stone culvert 12 in. square, and then a 4-in. pipe for 1,485 ft. In 1852 a larger pipe was laid for 400 ft. from the pond, and in 1856 water was pumped, probably from wells on Union street, to aid in the supply.

In 1858 contracts were made for the use of water from springs in the city for a limited time. The supply continued deficient until 1864, when works were built after the plans of Phineas Ball, C. E., taking water from Lynde Brook.

The population of Worcester at this period was 28,000, and the valuation $16,698,750. The city was then supplied with water, in addition to the Bell Pond aqueduct, according to Mr. Ball's report, in the following manner:

"*First.* The Allen, or Spring Water, as the proprietors now call it, supplying some thirty-seven different parties, almost wholly on Main street. This aqueduct has not far from two miles of pipe, its source being near Adams square, and about 120 ft. above Lincoln square.

"*Second.* The Paine Spring aqueduct, the source of which lies at the foot of Laurel Hill, on the east side of Hanover street, and some 25 ft. above Union street, at William A. Wheeler's foundry. This supplies at least 125 families and shops, on School, Union, Main, Thomas and Summer streets. The amount of pipe laid is about one mile.

"*Third.* The Rice aqueduct, supplying parties in the neighborhood of Grafton and Franklin streets, to the number of 61 families, and two steam engines, which are estimated equal to 24 families."

The new source of supply has a drainage area of 3 square miles. Across Lynde Brook an earth dam, with rubble breasting wall, was built. The waste pipe was 16 in., and the outlet pipe 12 in. in diameter, both being made of wrought iron, lined and covered on the outside with cement. The outlet pipe was laid from 8 to 10 ft. below the top of the original soil, imbedded in cement mortar. In this dam was built a rubble stone spiling wall, laid in cement, which rested in the hard pan. It was 18 in. thick and extended down 4 or 5 ft. below the pipes. The earthwork was made of good material and well compacted in layers of about 8 in. in thickness, the base being puddled as well as it could be without cutting. This dam was not finished till the summer of 1865. The dam thus built was 27 ft. high above the bed of the brook. Its inner slope was 2 to 1, and paved with rubble paving, from 12 to 18 in. in thickness, and the rollway was 4 ft. below the top of the dam. The breadth of the base of the dam was 135 ft., its length on top 287 ft.

In 1870 the dam was raised 15 ft. It was necessary to widen the base of the dam, and all the loose material was cleared away where the foundation of the new part was to rest. The foot wall was removed and a new one laid far enough below to receive the slope of the enlargement. This wall was 11 ft. thick at the base and 14 ft. high. The spiling wall in the new part was placed 28 ft. south of the old one, lower down the valley. It was made of two rubble walls, each 18 in. thick, laid parallel with each other, 4 in. apart, filled between with concrete. The original pipes were cut off at the gate-houses, and filled from that point with concrete and stone. The two gate-houses were filled four feet with solid masonry. New gate-houses were constructed, and two 24-in. pipes laid between them, one being used as a waste pipe. These gate-houses were located in a new place, 173 ft. apart.

A trench was dug through the dam from the lower to the upper gate-house, and a pipe-gallery or arch constructed therein. This arch was 8 by 7 ft. inside, and in form a little less than a complete semicircle. The walls of this arch were double, filled with concrete, and about 4 ft. thick, made of split stone, laid in cement mortar. The floor of the arch was horizontal, first being laid with flagstones, and afterward paved with Belgian blocks, laid in cement. This floor was put in after the arch was made, and the whole seemed to be substantially water-tight. The outside of this arch, instead of being rough so as to obstruct the water if inclined to follow the surface, was

made as smooth as possible, by plastering it over with cement, after laying around it a course of brick. The spiling wall, though extending below this arch, and thus forming a cut-off, was not bonded to it, nor had it any positive water-tight connection therewith.

It will be seen that the first dam was cut in two by the building of this arch.

In September, 1874, a leak appeared in the floor of the archway 22 ft. from the upper gate-house and 20 ft. above the heart wall, which gradually increased. Measurement of this leakage was begun Oct. 22, 1875, and showed the following results:

October 22, 1875	39,810	gallons	in 24 hours.
November 1, 1875	39,810	"	"
December 1, 1875	48,448	"	"
January 1, 1876	39,810	"	"
February 1, 1876	39,810	"	"
March 1, 1876	39,810	"	"
From March 1 to and including			
March 25, 1876	39,810	gallons	in 24 hours.
" 26, "	48,448	"	"
" 27, "	48,448	"	"
" 28, "	67,542	"	"
" 29, "	57,840	"	"

On March 30 the dam broke away, and great injury was done along the stream below. A new dam was built, after the plans of W. J. McAlpine, C. E., which has stood well. The old hearting walls were removed. A puddle wall was toothed into the original soil. All continuous vertical and horizontal lines in joining the old and new banks were broken up by benching and toothing. Three ines of cast-iron pipe were laid through the dam and enveloped in rubble masonry with three collars or cross walls all of irregular exterior surface.

Between the dam and the reservoir a 16-in. wrought-iron and cement pipe was laid in 1864. The distributing reservoir was built in 1865-7. It is in excavation and embankment, with the bottom and slopes covered with 2 ft. of puddle. The bottom was covered with gravel 6 in. thick, and the slopes with a 12-in. dry wall of stone on 3 in. gravel.

In 1870 the supply from Lynde Brook was deficient, and for 24 days about 36,000,000 gallons were pumped from a pond between the two reservoirs.

After the breaking of the Lynde Brook dam, in 1876, a temporary supply was procured by diverting Parson's Brook into the distributing reservoir by a dam of boulders, backed with earth, and by pumping from Coe's Pond, which was continued until January, 1877.

The distribution pipes are partly of cast iron and partly of wrought iron and cement. Up to December, 1877, the date of the last report which it has been possible to obtain, there were 16 miles of pipe in use, 28.5 miles of which were less than 6 in. in diameter. There were then 592 fire hydrants in use, and 2,423 meters. The cost of construction to 1876 was $302,624.71. The annual reports give no statements of cost. The revenue in 1877 was $73,426.83. The consumption was about 3.5 million gallons.

The works were built under direction of a committee of the Common Council, and managed by a joint standing committee of City Councils, with the City Engineer and Water Commissioner. Phineas Ball was City Engineer to 1873, C. H. M. Blake, 1874 to 1887, and Percy Daniels in 1878.

Frank E. Hall was Water Commissioner for several years prior to 1878.

The population of the city in 1880 was 58,295.

(TO BE CONTINUED.)

Articles of incorporation of the Fort Wayne & Southeastern Railway Company, with a capital stock of $600,000, were filed with the Secretary of State of Indiana last week. The line of the proposed road will be from the dividing line of Ohio and Indiana, in Mercer and Paulding counties, to Fort Wayne, in Allen County, and will be thirty-two miles in length. The directors of the company are L. M. Ninde, Montgomery Hamilton, A. C. Trentman, George Dewald, Frederick Beach, D. S Kell and Charles McCulloch.

THE NEW YORK AND BROOKLYN BRIDGE.

(*Continued from page* 263.)

MATERIALS USED IN MASONRY.

"The masonry of the towers below water is mostly of limestone, except the facing of the upper two courses, which is of granite. The backing above high water and below the roadway is mostly granite, all the remainder of the work being granite.

"The anchorages were built entirely of limestone, with the exception of the corners, the front arches and the cornice. There were also about 650 cubic yards of heavy granite blocks in each anchorage, placed immediately over the anchor-plates, in order to secure a good hold upon the masonry above. * * *

"The gravel used in concrete was beach gravel from various points on the north shore of Long Island. It contained a little sand, but was entirely free from dirt. The sand at first used was from Red Bank, off Staten Island; but the excavation for the Brookiyn anchorage furnished an abundant supply for all subsequent work. The cement used has been of the various brands known as Rosendale, no lime having been used at any time. This, being a slow setting cement, there is a great advantage in using it where heavy blocks of stone are to be set and adjusted.

"The ordinary proportions of sand, etc., used have been by bulk—for mortar, one part cement and two sand; for concrete, one part cement, two parts sand, and four parts gravel; around the anchor bars and at some other points, the proportions were, one, two, and three. No grouting has been permitted, except in rare cases where no other method was practicable; the general rule being, that all joints must be wide enough, at least for mortar; free use being made of 'swords' and rammers so as to insure perfect filling of joints.

"In making up joints in the backing (wherever the spaces were wide enough to admit them) broken stones of irregular sizes, from a cubic foot down, were rammed into the concrete, until the spaces would receive no more. Great care was always taken to keep the work clean and to wet the faces of the stone. The face joints were dug out to a depth of 1½ inches and pointed with pure cement motar: a bead finish of about ¼-inch projection being put on with a tool. The pointing has never cracked, except when done too late in the season, or when the mortar was allowed to take its first set before using; re-tempered mortar is sure to crack.

"In this connection it may seem proper to state that whenever necessary, the work has been carried on in freezing weather, and no bad results have been observed. The tops of the various pieces of work were always gone over carefully in the spring. The concrete which had been put in late would usually be found disintegrated to a depth of 1 to 4 inches; but below this it always was perfectly sound. The rule seemed to be that it was unsound only so far as it was exposed alternately to freezing and thawing, and wherever it had taken a set before freezing, and not been thawed for some time, it was sound. * * *

THRUST OF ARCHES.

"Before construction, a careful analysis was made of the thrust line of pressure, etc., in the arches under the various conditions of load to which they would be subjected. This showed that the center line of pressure, resulting from the pier only, intersected the bases of the outer shafts at the roadway, at about one-third of their thickness from the outer faces; and that with the bridge completed, the intersection at this plane was close to the vertical lines through the center of gravity of the shafts.

"The deflection of the center span of the cables is about 128 feet, and of the land spans about 187 feet, and the resultant of pressures from the cables falls in each pier slightly toward the river side of the center line.

IRONS INSERTED IN THE MASONRY.

"To provide against possible changes of form, or accident during construction of the arches, the following precautions were taken:

"At the top of the third voussiors, four heavy irons were anchored into the masonry on each side of each arch, to which 3 in. round iron rods spanning the arches were attached. Each rod was provided with a turnbuckle for tightening. Aside from serving to stiffen the arches, these rods served a very convenient purpose, as supports for scaffolds, while removing the centers and pointing the joints.

"Permanent strengthening bars were inserted in both the first and second courses over the arches; there being in all 6 bars, 5×1¼ in., over each arch anchored well into the shafts on either side.

"Experience has shown the necessity of another precaution to obviate the evil effects of the unequal distribution of pressure over the base of the masonry. By simple inspection it will be seen that the pressure per square foot at the base of the connecting wall is less than half that at the base of the shafts. Hence there would be a tendency toward less compression and settlement under the connecting walls, and a consequent bulging upward at the roadway, causing vertical cracks in the connecting walls. This actually occurred to a limited extent in the Cincinnati bridge. To obviate this tendency, bars were inserted in the top of the fourth, fifth and sixth courses below the roadway, in all 16 bars, 5 × 1¼ in., long enough to anchor into the shafts. In addition, the stones of the connecting wall for several courses were clamped together by 1½ in. round iron clamps.

"Three sets of 2×10 in. steel bars were inserted at each side of the pin, at the roadway, to serve as attachments for the under floor storm cables.

"A set of flat iron bars were inserted at 20 ft. below the roadway, as attaching points for holding down stays.

"Twenty bars, 5×1½ in., reaching entirely across the tower, were inserted in the top of the second course below the saddle plates; and in the course below this, 16 other bars, 5×1¼ in. The ends of these serve as attaching points for a portion of the long stays to the river and land spans of the roadway.

"Small irons were inserted at frequent intervals to serve as attaching points for scaffolding, stairway, etc.

"On each pier, on specially prepared beds, 4 saddle plates, each 8 × 16 ft., and weighing 11 tons each.

"All irons were thoroughly galvanized before insertion. The middles and plates were thoroughly coated with boiled linseed oil. * * *

METHOD OF ERECTION.

"When the timber courses in the foundations were completed, three setting derricks were erected, one near the center of each shaft. These had masts of 56 ft. height, with cross-booms 35 ft. up, and strong back stays to take the thrust. The booms were horizontal, with a buggy traversing their length, so that the derrick commanded the entire area of a circle of about 35 ft. radius.

In Brooklyn, permanent hold-backs (dead men) were used for guying to, the system of guys being rectangular, and the three derricks being connected by sky-guys. This required a constant tightening of guys during the sinking of the caisson. In New York the guys were attached to the top of heavy inclined struts, 40 to 50 feet long, by eye-bolts with long screw-threads for adjusting. The struts were double, with a cross-head of oak. On each side of the bolt for the sky-guy was another bolt for connecting the holding-down rods; these were finally anchored to heavy screw bolts in the timber below the masonry. The struts used at first had a spread of 6 feet at the base, and the rods of three feet. As the work advanced and the rods were lengthened, this was found to lack in stability, and the spread was increased to 9 and 6 feet respectively.

"In computing the dimensions of temporary iron-work in detail, a load on wrought-iron of 10 tons was always assumed, and maximum strains of 8 tons per square inch allowed, the best Ulster iron being used, and, for guys, steel or iron ropes.

"For derrick falls, Manilla rope of best quality (4½ in. circumference) was always used; and no rope allowed to be used after it became seriously chafed by wear.*

"But too serious failures have occurred with these derricks. * * *

"With these derricks a rise of masonry of 20 to 28 ft. could be set without a change of position, small holes being left in the masonry at the points occupied by the derricks, which could be filled after the derricks were raised. The cast-iron footstep of the derricks had wrought-iron rings in top by which they could be withdrawn, thus saving their renewal.

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* No case of breakage of a fall ever occurred. Great care was always taken in leading a fall to prevent chafing. When possible, no leading block was put nearer to the drum than 20 feet, and the first blocks (which were usually permanent) were 18-inch iron sheaves lined with *metalline*, some of which has now been in constant use for eighteen months, with no perceptible wear. It has been found economical to turn the grooves of all sheaves, as a large saving in wear results from so doing.

CORRESPONDENCE.

THE CHAUDIERE BRIDGE.

MONTREAL, July 4, 1881.

EDITOR ENGINEERING NEWS:

In your issue of the 2d inst., a Toronto correspondent, "J. D. H.," states that, in your description of the floor system of the Chaudière Bridge, you are incorrect when you state that the design was not in use before the construction of that bridge, and then adds that the floor system mentioned is a design adopted by the Grand Trunk Railway in the year 1877.

I am afraid your correspondent has made this statement without a full knowledge of the facts or of the details of the construction of the bridge. Will he be kind enough to state where the floor system similar to that on the Chaudière bridge may be seen on the Grand Trunk Railway, and will he give a full description of it?

Yours truly, P. WM. PETERSON,
Chief Supt. Chaudière Bridge.

LEVEL NOTES.

ENGINEER'S OFFICE SEVIER VALLEY RY.,
Lat. 39° 10', Long. 110° 40',
June 24, 1881.

EDITOR ENGINEERING NEWS:

In your issue of June 4, Mr. J. H. Leavenworth objects to the level notes being worked in the field.

His method may answer for some country surveyor who has a few miles of ditch to level each year, but for railroading in a rough country, a leveler who could not work his notes in the field and keep up with the transit party would be of no account whatever.

I have yet to see the engineer who could make a good location through a rough country, who did not keep his profile up in the field, and know at all times exactly what his grades and work were. I am now making a location through a country which has a slope of about four feet per hundred, and is badly cut up with ravines from thirty to two hundred feet deep, and yet my leveler usually keeps his notes worked to within five hundred feet of the transit party.

The roadman also keeps notes of all turning points, as a check.

FRANK P. DAVIS,
Asst. Eng. S. V. Ry.

DESIGN FOR MONUMENTS.

NORTHERN PACIFIC RAILROAD COMPANY,
Miles City, Montana, May 24, 1881.

EDITOR ENGINEERING NEWS:

The interest displayed in your columns regarding monuments for boundary lines leads me to

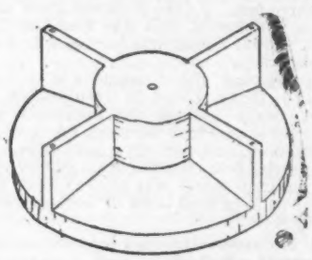

FIG. 1.—SYMMETRICAL PROJECTION OF CAP.
Viewed from above.

call your attention to a design intended to supply the need, which provides for an interchangeable system of lettering. The latter, when placed, may not be altered without destroying the monument (patent filed May 24, 1880, No. 232,972), and consists of a series of dove-tailed grooves for the reception of letter plates.

The post, which is designed for general use, and especially adapted to government surveys, will weigh from 6 to 7 lbs. It is principally made of steel castings, consisting of fluted body or shaft 3½ ft. in length, with flanges at base to hold it in position when set, and an inverted cone projecting from the center or vertical axis that rests in the socket of a false point made of

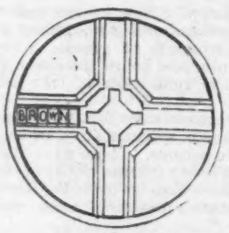

FIG. 2.—HORIZONTAL SECTION, BASE OF CAP.
Inverted view. Letter grooves.

brass and buried in the earth to mark the spot upon which falls the corner, remaining though the post be destroyed. Near the top or head of the shaft are grooves, for the

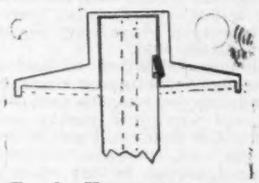

FIG. 3.—VERTICAL SECTION.
Head and Cap Clamped in Position.

reception of figure or letter plates made of glass or other material, over which, with the head as a tenon, a mortised cap is fitted and securely wedged; which not only locks the system of letter-

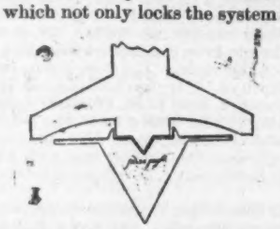

FIG. 4.—VERTICAL SECTION.
Base of Shaft.

ing in the shaft, but also another system in the under part of the cap placed at an angle of 45° to the first, as is required for marking government sections.

Four thin perpendicular walls are mounted on

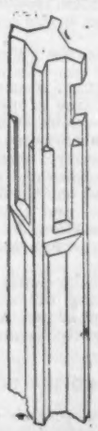

FIG. 5.—HEAD OF SHAFT.
Letter Grooves.

the top of the cap radiating from the center to the four points of the compass, with the letters N., S., E. and W., indicating the cardinal points.

These expanding wing-like plates render it very conspicuous.

I have plans with which I hope to make it non-corrosive.

This post, a large monument and an engineer's hub, will effectually and permanently mark any corner.

J. C. ISAACI.

BRIDGE PINS—THEIR SIZES AND BEARINGS.*

BY J. A. L. WADDELL, C. E.

The subject of "Bridge Pins" is one deserving of more consideration than has been accorded it by engineers and authors of technical works. Until 1878, when Mr. Charles Bender, C. E., presented his paper on "Proportions of Pins used in Bridges" to the American Society of Civil Engineers, very little was known concerning it, the usual custom among engineers when proportioning pins having been to allow one square inch of pin area for every eight or ten thousand pounds of shear in the section most subject to shearing stress. As Mr. Bender states generally, and as will be shown further on to be true for iron bridges, it is not the shear, but the bending moment which causes the greatest tendency to rupture, so that in any iron structure it will be sufficient in finding the sizes of pins to calculate the greatest moment induced in them by the various members coupled thereon and to proportion accordingly; due regard being paid to the stresses in the eye-bar heads. To illustrate the method of so doing, and to facilitate the calculations, are the objects of this paper.

Before proceeding to any original investigation it will be well to review and summarize the results of what has been written on the subject by Mr. Bender, Mr. B. Baker in his excellent work on "Beams, Columns and Arches," and by Professor Burr in his treatise of "Bridge Stresses," which, by the way, is undoubtedly the most complete and satisfactory work upon that subject that has yet been published.

The principal conclusions arrived at by Mr. Bender are—that, for a well-fitting pin of large diameter, a pressure on the bearing surface of 12,000 pounds per square inch is not too large—that for simplicity it is well to assume that this pressure is uniformly distributed over the diameter of the pin—that wrought-iron, after millions of impacts, may break on the side where the stress is tensile, but never on the side where it is compressive, the ultimate resistance to crushing being about 60,000 pounds per square inch—that the shearing stress at the center of a pin is one and three-eighths times the average shear on the whole section—that in iron and steel the ratio between the greatest allowable tensile and the greatest allowable shearing stresses should be as five to four, which would make the uniformly distributed shear 5,820 pounds per square inch to correspond with a tensile stress of 10,000 pounds per square inch, and that owing to various considerations, iron in pins may be strained more than in tension members, or up to 12,000 pounds per square inch, where the limit to tension is 10,000 pounds per square inch.

Mr. Baker treats of pins merely incidentally, as his work pertains to the properties of iron and steel in general. He finds that for iron in solid circular beams the average value of φ is $\frac{1}{11}f$, where f is the ultimate resistance per square inch to rupture by tension, and φ the difference between the apparent ultimate resistance per square inch to rupture by bending and f, according to the equation $F=f+\varphi$, F being the apparent ultimate resistance per square inch of the extreme fiber which first gives way; and that for steel the value of φ varies between $1.7f$ and $1.9f$. Professor Burr devotes five pages of his book to the subject of pins and illustrates the particular case of a suspension bridge cable-pin, and a general case for ordinary truss bridges. His treatment leaves little to be desired, still it may be worth while to enter more into detail and investigate a few cases that often occur in practice. Many of the older writers on the resistance of materials, for instance, Trautwine and Wood, seem to greatly under-estimate the capacity of wrought iron to resist bending and compression. Trautwine makes the modulus of rupture 45,000 pounds, while Wood places it between the ultimate resistance per square inch to tension and compression. On the contrary Baker states it to be over fifty per cent. greater than the ultimate resistance to tension, and gives 60,000 pounds as the ultimate resistance to compression, in which he is supported by the opinion and practice of many prominent engineers.

The accompanying tables were made by the

*Paper read before the Pi Eta Scientific Society, Rensselaer Polytechnic Institute, Troy, N. Y.

writer for Messrs. Raymond & Campbell, bridge builders, Council Bluffs, Iowa, and it is with their permission that they are now published.*

The modulus of rupture for iron was assumed to be 75,000 pounds, which is somewhat less than the value found by Baker, and the working resistance was taken as one-fifth of that amount. The distributed shear was taken equal to 5,800 pounds per square inch, and the working compressive stress 12,000 pounds per square inch in accordance with the results of the investigations of Bender. These values are for the chord pins in railroad bridges (see table I.). The corresponding values for highway bridges (see table II.) are 18,750, 7,250 and 15,000 pounds. Table III., for "lateral pins" was calculated for values of 22,500 and 8,700 pounds for the working resistances to bending and shearing respectively, corresponding to a working tensile stress of 15,000 pounds. There is no table of bearings for lateral pins, as such a table would very seldom be needed.

The upper horizontal line in the table of bearings, tables IV. and V., gives the diameter of the pin; the first vertical line the necessary width of bearing, including both the channel and the reinforcing plate or plates, and the other vertical lines the pressures on the bearing surfaces. By the use of these tables much labor and time may be saved. The method of procedure is the following: The pressure which the pin is to carry is to be taken from the diagram of stresses. A trial diameter is thus to be assumed. The vertical column in either tadle IV. or V., headed by this diameter, is to be followed down until a number nearest the pressure to be carried, is found. At the left end (or right) of the horizontal row thus located will be found the proper width of bearing. Knowing the width of bearing, diameter and pressure, the moment M', to which the pin is subjected, may be at once calculated. Turn then to tables I., II. and III. and see if M' is equal to, greater or less than, M corresponding to the trial diameter. If M' is equal to or less than M, the assumed diameter will give a pin sufficiently strong; otherwise another trial must be made. After a little experience the first trial will be sufficient. A consideration of other details, such as width and depth of eye bars, etc., will frequently aid very much in these trials.

The ton used in these calculations is the American ton of 2,000 pounds. The tables of "Pins" are self-explanatory. To employ them for steel, divide the moment as found from calculation by two and use the quotient as if for iron. Should the resistance to shearing of any steel pin be required, multiply the value given in the table by 1.7. To employ the tables for steel bearings, divide the pressure on the bearing surface as found by inspecting the diagram of stresses by two and use the quotient as if for iron; the dimensions found will be for steel. That the results thus obtained will be on the side of safety is shown by the following: The experiments on "Hay Steel" made by General William Sooy Smith, while erecting the Glasgow bridge over the Missouri river, gave the ultimate resistance to crushing about 140,000 pounds per square inch, and the ultimate resistance to tension from 80,000 to 96,000 pounds per square inch. According to Baker the average of the latter would correspond with a modulus of rupture of about 158,000 pounds; while the shearing resistance, according to Bender, is a direct function of the resistance to tension.

These points being settled, let us investigate a few problems.

To find the least value of the ratio of the diameter of pin to depth of eye-bar in an iron bridge, by considering the tension in the bar and pressure between the pin and bar.

Let w = width of bar.
" d_1 = depth of bar.
" d = diameter of pin.
" C = ultimate resistance per square inch to compression.

Let T = ultimate resistance per square inch to tension.

Then wd_1 T = tension in bar, and wdC = compression on pin and eye. These of course are equal, and as $C = 60{,}000$ pounds and $T = 50{,}000$ pounds there results the equation $d = \frac{5}{6}d_1 = 0.833d_1$ which shows that the diameter of the pin should never be less than 83 per cent. of the depth of the bar. It is possible, though, that good iron of 50,000 pounds tensile strength will resist a little more than 60,000 pounds in compression. Consequently d may be taken at $0.8d_1$ as a matter of convenience.

To find the proportion between width and depth of bar for smallest allowable pin in an iron bridge:

Let w, d and d_1 ($= \frac{5}{4}d$) represent the same quantities as before.

T = greatest working resistance per square inch to tension; then $w \times \frac{4}{5}d \times T$ = tension in bar, and $\frac{4}{5}dTw^2$ = moment of stress in bar, the lever-arm being taken = w. Now for a certain tension in a simple bar pulling on a pin against a bearing, or, what is effectively the same, a pair of bars pulling in opposite directions, in order to make the pin as small as possible (d not exceeding $\frac{4}{5}d$) the depth of the bar should be made as small as is consistent with the resisting moment of the pin, consequently, the width must be made as great as is consistent with that limit. The greatest working moment for the pin is expressed by the formula $M = \frac{RI}{d_1} = \frac{R\frac{1}{4}\pi r^4}{r} = \frac{11}{125}d^3R$,

where R is the working resistance per square inch to bending. Equating this value of M to the moment previously found, gives $\frac{11}{125}d^3R = \frac{4}{5}dTw^2$, but $R = \frac{4}{5}T$, which substituted gives $w = 0.343d = 0.274d_1$ = about one-fourth the depth of the bar.

To find the greatest working shearing stress (supposed to be uniformly distributed) in terms of the working resistance to tension: Let S = actual varying resistance to shearing, considered uniformly distributed.

The greatest value of S will correspond to a value of $w = 0.274\ d_1$, for, suppose the moment to remain at its maximum value, and the dimensions of the bar to vary, consequently the stress therein also, the tension in the bar will be greatest for the value of w, corresponding with the greatest value of d_1, therefore the shear will also be greatest for that value.

$$\therefore \tfrac{4}{5}wdT = \tfrac{4}{5}d^2T \times 0.343 = \frac{\pi d^2 S}{4} \text{ and } S = 0.5457\ T.$$

For $T = 10{,}000$ pounds, $S = 5\,457$ pounds, but the greatest allowable value for S is, according to Bender, $= 5{,}820$ pounds. This proves that if an iron pin be properly proportioned for crushing and bending it will be strong enough to resist shear, and in fact that before the pin could shear, it would either break by bending or crushing, or the eye of the bar would give way. A similar investigation for steel bridges where $T = 16{,}700$ pounds $C = \frac{7}{4}T$ and $R = 1.8T$ gives $d = 0.5714d_1$; $w = 0.1816d_1 =$ about $\frac{1}{5}d_1$ and $S = 11{,}824$ pounds = the actual shearing stress for the case when the pin is strained up to bending limit, and the ratio $\frac{w}{d_1}$ for that condition of stress is at its maximum, consequently, also the area of the bar, the tension therein and the shear on the pin at their maxima. But the greatest allowable shear, according to Bender, is $\frac{4}{11} \times \frac{11}{14} \times T = \frac{4}{7} \times 16{,}700 = 9{,}716$ pounds; so that for a pair of steel bars pulling on a steel pin in opposite directions, or a single steel bar against a steel bearing, the pin in certain cases will be liable to rupture by shearing, and will therefore have to be proportioned to resist that stress.

It is the custom on some railroads to use pins whose diameters are only two-thirds of the depth of the deepest bar coupled thereon, while many bridge companies proportion their pins by a certain percentage of depth of bar irrespectively of the number of bars attached thereto; and there are large railroad bridges throughout the country where the pins are only three inches in diameter. It is needless to comment upon these facts, the incorrectness of all such practice being obvious. It is strange that there are so few bridges which fail on account of the weakness of their pins, but the time will come when the latter, owing to repeated strains exceeding the elastic limit, will give way suddenly and cause the instant downfall of the structure of which they form a part.

After the diagram of stresses and sections for a bridge has been made out, comes the proportion of the pins; a matter which will sometimes occupy more time than did all the previous work. Knowing the sizes of all the bars in the structure, the clear width between the inner faces of the top chord channels, and consequently that between post channels, can be found, after which the arrangement of all the bars in the bridge can be decided on. Care must be taken in performing the latter that no two consecutive chord bars or ties coupled on the same pin pull in the same direction, that the lighter set of bars be placed on the outside, and that the diagonal ties and beam hangers be kept close together. Especial care is needed at the panel point where the number of chord bars is different in the consecutive panels. It is possible to arrange the bars so that there will be an extremely large moment produced, or so that it will be smaller than any other panel point of the bottom chord. The neglect of any of these precautions will cause an undue bending moment of the pin.

The arrangement completed, the next questions to be decided are, first, under what condition for loading will each pin take its greatest bending moment, and second, at what point on the pin will this be found. In large bridges and in many well-proportioned small ones, the bottom chord pins are subjected to their greatest bending moments when the bridge is fully loaded. Under this condition the stresses in the chord bars can be taken from the diagram of stresses, but those in the main diagonals and counters must be calculated for the load covering the whole bridge, and their horizontal and vertical components be ascertained. If the load be an uniform one, the only effect of the counters on the pin will be on account of their widths affecting the lever-arms of the stresses in the other members.

After having had some practice, one will often be able by simple inspection to decide at what place the greatest moment of flexure will exist, but, if not, it will be necessary to calculate the values of both horizontal and vertical moments at different points and find where their combined result is a maximum. As Professor Burr shows, the actual moment is represented by the diagonal of a rectangle whose sides represent the vertical and horizontal moments. It is usually more convenient to square the component moments, add the results and extract the square root of the sum, than to make out a diagram.

A very handy little instrument for this and many other office purposes could be made by having a graduated square with a longitudinal slot in each of the two arms, to which could be fastened another graduated arm, also slotted, and movable about, bearings passing through the slots. By its means could be found without calculation the length of a diagonal on any two sides.

The movements of the stresses can be easily recorded by drawing two curved lines, as shown in the accompanying diagram, representing the

direction in which the stresses tend to bend the pin, and writing each moment as calculated under one or other of them according to whether it would produce positive or negative rotation. The difference between the sums of each column will give the actual horizontal or vertical moment, as the case may be. The condition that a load covering the whole bridge may not produce the greatest moment in the bottom chord pins is either when there is a single counter coupled at the center of the pin, or a main diagonal coupled at a distance from the member that takes up its stress. As a rule, single counters and single beam-hangers are to be avoided on account of the unnecessarily large bending moments they produce. The size of pin for the hip-joint depends greatly upon the arrangement of the bars which it couples. In a double intersection bridge where there are two hip verticals, two long diagonal and two short ones, the best arrangement is to put one pair of diagonals on the outside of the chord and the other pair inside, close to the bearing, the verticals coming next and being kept apart by a filler. Sometimes it is not advisable to couple outside of the chord, in which case the moment would become so great that it would necessitate the employment of a pin whose diameter would make the heads of the eye-bars too large for the space allotted them. In such a case a steel pin can be used to advantage; or it may be expedient to insert an intermediate bearing.

Hinged ends often require large pins, for the entire stresses in both chords and batter-braces come upon them with great leverage, due to the necessarily large bearing surface. Such a connection is not advantageous; it is better to allow at least a portion of the bearing to abut. Hinged ends are a great convenience in erection, but necessitate an increase in the sizes of the batter-braces and end-panels of the chords. Mr. Charles Campbell, civil engineer, has designed a detail which overcomes this difficulty in an iron bridge. He places two connecting plates on the outside of the chord, and two on the inside of the batter-brace, through which the pin passes, and which respectively abut against plates riveted to the outside of the batter-brace and to the inside of the chord. The channels in the chord abut against those in the batter-brace, and all

*The above four tables we have not published on account of their length. They may be had by those interested by application to the Society at Troy, accompanied with fifty cents, which is a reasonable price for the pamphlet.

abuting surfaces are planed to fit exactly, so that when the pin is driven into place, the whole joint is as rigid as if it were riveted. Of course this detail demands neat workmanship, and is, consequently, somewhat expensive, but the satisfactory result attained more than counterbalances the extra cost.

Where the upper lateral rods do not couple on the top chord pins, the calculations for the sizes of the latter are very simple, as they take up their greatest moments with the greatest stresses in the diagonal ties. It will usually be found sufficient to make their diameter four-fifths of the depths of the ties which they couple, especially so in combination bridges, where the bearings are close together. It is probable that in this last case the true moment will lie between those expressed by the formula $P = \frac{1}{4}\ Wl$ and $P = \frac{1}{8}\ Wl$, corresponding respectively to a center and an uniformly distributed load. It will be sufficiently exact to assume it to be equal to $\frac{3}{16}\ Wl$. But if the lateral rods do couple on the chord pins, as is often the case, the calculations become rather complicated. It will be necessary to resolve the moment produced by the web members into its vertical and horizontal components (or to speak more technically, to resolve the web stresses into their vertical and horizontal components and find the moments of same) then find what conditions of lateral stress taken in connection with the horizontal component will produce the maximum horizontal movement, account being taken of the effect of the probable initial tension in the lateral rods.

One only of two lateral rods meeting at a panel point can be subject to wind stress at the same time, and it is of course, the outer one which by itself will produce the greater moment. It is obvious, too, that it is only the longitudinal components of lateral stresses which can produce a bending moment in the pin. Having found the greatest horizontal moment, the greatest actual moment can be ascertained by combining that value with the vertical moment previously found. But this is not all: the transverse components of the lateral stresses produce direct tension in the pin, which will increase the stress on the side subjected to tension.

The method of proportioning a pin to resist the combined effect of these two stresses will be best illustrated by an example: Two $1\frac{1}{2}''$ lateral rods are coupled on a pin, each having an initial tension of 5,000 pounds and an inclination of 45° to the planes of the trusses. Suppose that the rods are flattened out to $\frac{7}{8}''$ where attached to the pin, that the bearing surface at each end of the latter is $1\frac{1}{2}''$ wide, that the moment produced by the web members is 20-in. tons, and that these members make angles of 45° with the verticals. Calling for convenience the sine and cosine of 45° equal to seven-tenths, the horizontal and vertical components of the web stresses will each equal 14-in. tons. The lateral rods should always be so placed that the effect of the stress in the outer one will be to diminish the horizontal component of the web moment, or in other words the outer rod at any intermediate panel point should always point toward the center of the bridge, and the inner one to the nearest end. Supposing such to be the arrangement in this case, the greatest moment will occur when the inner rod is strained to its working limit, which is about nine and one-half tons. The longitudinal component of the latter is 6.65 tons and its lever-arm 1″; its moment is therefore 6.65-in. tons. The initial tension in the outer rod being 2.5 tons, its longitudinal component will be 1.75 tons and its lever-arm $\frac{7}{8}$, or, owing to imperfect connection, say $\frac{3}{4}''$, making the moment 2.62-in. tons, which would produce a maximum horizontal moment of 18.03 tons, say 18 tons. This value combined with the 14-in. tons vertical component would give about 23-in. tons for the greatest actual moment. Supposing the structure under consideration to be a railroad bridge, this value would correspond very nearly to a $3\frac{1}{8}''$ pin, the area of which is 7.67 square inches. The greatest tension produced in the pin by the transverse components of the stresses in the lateral rods is $6.65 \times 1.75 = 8.40$ tons, corresponding to an area of 1.68 square inches. At first thought this would appear to determine the size of the pin, making it 9.35 square inches in section, which would correspond with a $3\frac{1}{2}''$ pin: but such is not the case. A $3\frac{3}{8}''$ one would be sufficiently strong and possibly a $3\frac{1}{4}''$ one also. Let us try the latter. The stress in the extreme fiber caused by the bending moment can be found by the following proportion (vide table)—25.3 : 23 :: 7.5 : x which would make $x = 6.82$ tons. The direct tension of 8.40 tons distributed over the 8.3 square inches of surface gives a tension of 1.01 tons per square inch, which added to 6.82 tons, makes 7.83 tons, showing that theoretically a $3\frac{1}{4}''$ pin would be a little too small. Practically, though, it would be large enough, for the lateral rods are seldom, if ever, strained up to their working limit. The direct tension is an important feature in small pins.

Some engineers might think that there ought to be a distinction made between the moments caused by the lateral and those caused by the web members. Such is not the opinion of the writer, for the chord pins, being subjected constantly to great stresses, should not even occasionally be strained much beyond the limit allotted them. The pin table corresponding to a tensile stress of 7.5 tons per square inch is intended for those pins that are used in the lateral systems only, and, therefore, would not be employed for the top chord when the lateral rods are coupled on the chord pins. The pin can be relieved of a large portion of the transverse components of the lateral stresses, by letting the rods pull against a piece of channel bar or something similar attached to the lateral strut, and through which the pin passes.

In small top chord pins another consideration comes into play. The end of the pin has to be turned down and a thread cut on the turned end in order to screw on the pin pilot—an apparatus used to put the pin in place, when there are stresses in the ties that it couples—so it is possible that the reduced section will not be sufficient to resist the direct tension, in which case it will be necessary to increase the diameter. The principal objection to the use of large pins is not always the undue weight of the pins themselves, but the increased size of the chord and tie bar heads and the room that they take up.

On the other hand, it is not always desirable to use the smallest possible pin, as the width of the bearing is an inverse function of the diameter of the pin; so, if owing to the necessity of a large number of rivets, the reinforcing plates be long, it might be economical to increase the diameter so as to reduce the width.

ADDENDUM.

Since the above paper was presented to the society, Messrs. Carnegie Bros. & Co. have issued a new edition of their "Pocket Companion," which contains tables of bearing and resisting moments of pins. It may appear superfluous to publish those accompanying this paper, but the writer thinks that the bearing tables will be found a little more convenient than those of Carnegie: besides there is a difference in the tables of moments. Carnegie uses 20,000 pounds for the working resistance to bending of steel, which would correspond with an ultimate resistance of 100,000 pounds. It is very poor steel which cannot be relied upon to resist considerably more than that amount. Of course, if the steel employed does not come up to the strength of 150,000 pounds, it will be necessary, in applying the tables, to divide the ascertained moment by some other number than 2, before searching for the size of pin.

EFFECT OF SEWAGE ON IRON.*

BY CHARLES O. THOMPSON, OF THE WORCESTER (MASS.) FREE INSTITUTE.

In 1857 the city of Worcester walled in the Mill Brook for its main sewer.

This stream, one of the important affluents of the Blackstone River, flows through the city in a southwesterly course from Salisbury Pond, and along its valley a considerable part of the heavy manufactories of the city are placed. At two points, a mile apart, a sufficient fall occurs to be turned to account for motive power, and at many points it was the right and practice of the riparian proprietors, prior to 1867, to use the water for steam and other manufacturing purposes. But the multiplication of branch sewers all leading into Mill Brook soon rendered the water unfit for use in contact with heated iron, and the water privileges were soon abandoned under equitable arrangements.

A large number of cases involving interesting chemical questions arose during the progress of negotiations between the city on the one hand, enforcing its newly acquired sewerage rights, and the proprietors on the other, defending their time-honored riparian rights. For instance, did the sudden introduction of branch sewers add pollution to a stream already foul from riparian stables, pigstyes, etc.? or, if yes, did this increase in a few months equal that of the natural pollution of the stream during the preceding ten years while the city had been doubling its population?

Again, at a point just above the beginning of the dense manufacturing district, but below the works of the Washburn & Moen Manufacturing Company, the city gas-works discharged the usual waste into Mill Brook, and had done so from the beginning of the gas supply. If now, the sewage-water, at different points in the valley, was found to act violently upon the iron of boilers or to froth in a marvelous fashion, could a portion of that injurious action be traced to the gas-waste or even to the discharge of acid liquors from the wire-works?

Also the cloaca maxima, after passing the manufacturing district, emerges into an open, walled channel, and runs two miles to Quinsigamond village into a mill pond which, of course, becomes a settling basin. The accumulating filth gradually fills the basin, and does it all the faster by the indirect agency of an enormous growth of aquatic plants, which fatten on the garbage. These plants gradually form islands, and the extinction of the reservoir becomes only a question of time.

After leaving this mill pond the water still carries a great quantity of sewage, and at Saundersville generates a novel nuisance. A dam flows it over a large area so that the water is very shallow; aquatic plants with woody stems grow apace in the summer; the persistent stems are frozen into the ice in early winter, and form a genuine horizontal filter for the sewage matter under the ice; and the accumulation of solid matter around these multitudinous rigid stakes is sufficient to check the flow of the water and thus deprive the manufacturer of the use of his wheel during the winter months.

Before reaching Quinsigamond village the sewage stream passes sluggishly around the yard of the Pillar Copperas Company, where copperas is made by concentrating the pickling-liquors of the city shops—mainly of the wire-mill. Of course some vesicles of copperas-water are dismissed into the air, and much ammonia is exhaled from the sewer. When the wind is south the precipitation of iron oxides upon the roofs and sides of leeward houses goes on rapidly, and those persons who do not like bright-red houses are therefore compelled to gratify their æsthetic propensities by process of law. And all along the open sewer pollution of the atmosphere goes on at such a rate as to impair the public comfort if not to endanger the public health.

From this bench of cases, I have selected those which involve the action of sewage-water on iron as the only ones strictly consonant with the objects of this Institute, and will present them without regard to the order of time.

Mill River drains an area of 7.8 square miles, mostly a farming country, before reaching Salisbury Pond, and, after receiving the contributions of the city sewers, delivers at Quinsigamond Mill-Pond, an average daily flow of 4,000,000 gallons between April and December. The amount discharged into it from branch sewers, in dry weather was a daily average of 1,500,000 gallons at the time, 1872–73. The water supply of the city was 3,000,000 gallons a day. So that just half the water received from the service was carried off by the sewers. The average solid contents of a gallon of Mill Brook water before receiving any sewers is 36.29 parts per 100,000; that of the largest branch sewer 61.77; or, in brief, each gallon of water which comes in from the branch sewers contains more than one and a half times the solid matter carried by a gallon of the main sewer. But the total outflow from the side sewers being less than one-half that of the Mill Brook, the actual increase of pollutions by the side sewers is very small. Still it is enough to throw the responsibility of damage on the city. This is especially enforced by the consideration that the percentage of organic matter in the contributions of side sewers is twice greater than in the original stream. The first case involving iron was that of William T. Merryfield *vs.* the City of Worcester.*

The sewer flows past his works, and the water was used through a spray-head in a condenser. This water was slightly alkaline and contained 12.649 parts of solid matter per 100,000, 5.325 parts of which were volatile. Mr. Merryfield complained that the water corroded his condensers, and that this injurious action of the water had greatly increased since the establishment of the sewage system.

To decide this point experimentally, after an extended series of sewage determinations in the water at different localities, I took three samples of water—one from Salisbury Pond, one from a point below the discharge from the old gas-works, and

* Read at the Lake Superior meeting of the American Institute of Mining Engineers, August, 1880.

* See Mass. Reports, Supreme Court, 110, p. 216.

one from the flume at Mr. Merryfield's building. Three clean, covered iron kettles received 4,300 grams of water, and were kept at a temperature of 120° F. (the temperature of the condenser), on a sand bath, 12 hours. The iron suspended or dissolved in each sample of water was carefully determined before and after this digestion, and was found to have increased in the first 8.68 grains per gallon; in the second 8.45 grains per gallon; in the third 15.25 grains per gallon, or nearly double the first. The suggestion of these experiments is that the admixture of the gas-waste did not increase the corrosive action of the water, and that the sewage greatly increased it—76 per cent.

These experiments were repeated with weighted clean pieces of *bar*-iron, immersed in samples of water, in porcelain vessels; other conditions the same as in the first set. The air being excluded from the iron, the increase of action in third sample over first was 37 per cent Distilled water, under same conditions, took up 9.62 grains per gallon, or three-fifths of the quantity taken by the sewage water, and one and one-eighth the quantity taken by the water of Salisbury Pond. Repeated collateral experiments decided the question of corrosion against the sewage-water, and the double grievance of uncontrollable frothing and corrosion gave Mr. Merryfield some damages. It was an interesting conjecture, prior to these experiments, whether or not the quantity of alkaline salts in the sewage water would protect the iron from corrosion beyond the reducing power of the demoralized organic matter in which it abounds. It appears that this is the fact in Salisbury Pond water, but not in the sewage water.

THE DRIVE-WELLS.

In the valley of Mill River, ten drive-wells have been sunk at different points with the hope of obtaining water fit for boilers, so as to save the cost of the city water. Water is found at depths varying between 2′ at the north, to 50′ at the south end of the district within which they lie—perhaps one-half a mile long. Analysis of a sample at the North End Warren Thread Company shows:

	Parts in 100,000.
Total solids	132.0
Volatile portion	18.0
Mineral portion:	
Calcium sulphate	6.9
Magnesium sulphate	19.4
Sodium chloride	21.5
Calcium carbonate	9.2
Silica	57.0
	114.0
	132.0

Sample from the Worcester Felting Company's Mill, half a mile below:

	Parts in 100,000.
Total solids	92.1
Volatile portion	21.7
Mineral portion:	
Calcium sulphate	10.0
Sodium chloride	26.1
Calcium carbonate	6.8
Silica	17.0
Magnesia and iron	11.0
	70.4
	92.1

The water issues at the Worcester Felting Company's Works at a nearly constant temperature of 50° F., and the supply is inexhaustible. There appears to be a subterranean lake roughly parallel with Mill River, with a clay slate bottom, which dips south at an angle of about 30°, and undoubtedly approaches the surface again further south, forming a basin. This water has received the surface sewage of the city since the beginning, and has retained mainly the salt. How soon it will become available brine can be determined by a series of observations, but its action on iron is very interesting.

I found the inner surface of a two-inch supply pipe, through which the water is drawn into a tank, completely covered with a hard, smooth porcelaneous glaze about 1-23″ to 1-16″ thick. But the results of a series of experiments in exposing iron to the action of this drive-well water were perplexing enough though decisive against the expediency of using it in boilers. That is to say, it turns out to be cheaper to pay 25 cents per thousand gallons for city water than to use this for nothing, such is the mischievous behavior of this porcelaneous scale. Thus 200 grams of bar-iron exposed to this water lost in Exp. 1, .010 grams, in 12 hours; Exp. 2, .080; Exp. 3, .0456; Exp. 4, *gained* .010; Exp. 5, gained .099; Exp. 6, lost .042; Exp. 7, lost .0576; Exp. 8, *gained* .010; Exp. 9, *gained* .005; Exp. 10, lost .0856; Exp. 11, lost .0516. The pieces of iron were cut from same bar. In eight cases a loss, in three a gain—conditions being uniform throughout. I suppose the gains *may* be attributable to imperfect washing and drying of the pieces of iron preparatory to weighing. This initial corrosion of the iron goes to explain the inseparable union of the porcelaneous scale which forms in this water with the iron. It seems to be a simple case of the disadvantage of an iron cement.

Another case closely connected with this was a boiler 4 ft. long, which was used in a bakery, and presented one or two novel points. It was used with 25 pounds of steam. I took a 2″ flue from it. For 2′ 3″ from the bottom or up to the customary water line it was sound; then for 10″ the iron is discolored, pitted, corroded, and weakened by actual loss of substance to such an extent as to induce collapse of the flue under 25 pounds pressure. All the flues are in substantially the same condition. But the *boiler-shell* is sound throughout. The fuel used is coke.

The water shows at this point:

	Parts in 100,000.
Total solids	22
Volatile	8
Salt	10.19

and a copious deposit of clay. It was obvious, of course, that this water did not act chemically on the submerged part of the flues nor on the boiler-shell. What happened was this: During ebullition a muddy deposit containing salt accumulated, by way of spirting, on the surface of the flues and of the boiler-shell just above the water. This deposit dried on and adhered firmly to the iron. It must accumulate rapidly from such water as was used. The flues being under fire, burn out rapidly under this coating, but the shell escapes harm, being at a constant temperature due to the heated water.

The last case of interest arose from the desire of the city engineer to take the entire sewage of the main sewer through an iron pipe from a point just below the copperas works to Cambridge street, about 1,200 ft. The copious discharge of ferruginous water from the copperas works introduces a new element into the problem. The sewage water turns rapidly black after standing in open or closed glass bottles, in light or darkness—it becomes positively inky. I have never observed this phenomenon in sewage water from any point above these works. Bottles of it darken a little to be sure, but do not become black. It seems to be attributable to the reduction of the iron salts in solution by the organic matter of the sewage.

I found by trial that bar-iron lost 0.00012 of its weight when exposed to the action of this water for one week, while cast-iron lost an inappreciable amount. The reducing power of the sewage matter seemed to be greater than was required for the treatment of the iron under same conditions.

The engineer was relieved of the necessity of laying his iron pipe by a change in the plans of the Committee on Sewers; although I think he might have used cast-iron pipes with good effect.

In all these cases, and in many others, there is good reason to believe that *salt* is the constituent of sewage, which is most active in attacking and corroding iron; for in all cases where sewage water has acted on iron at ordinary summer temperatures, a copious precipitate of ferric hydrate has appeared, which it is difficult to explain on any other ground.

I propose to investigate the action of brine on iron, and report at some subsequent meeting of the Institute.

FIXING INTERMEDIATE POINTS IN VERY LONG STRAIGHT LINES.*

BY PROF. A. NAGEL.

The author enunciates the following general principle: Given stations two or more kilometers apart, one intermediate point at least should be fixed in the straight line joining them.

Two cases occur in work of this nature: either the view from one end of the line to the other is uninterrupted, or it is not so.

1. *When the View Between the Two Ends of the Line is Open.*—The intermediate point can in this case be found by two methods: by direct ranging, or by trial from the point itself. In the first, a transit instrument is set up at the one end, and directed on the other end of the line, when the intermediate point can be fixed in the vertical axis of the telescope by signalling to an assistant at the required spot. In the second method, the instrument is taken to the proximity of the point itself; which is found by turning the telescope first on the one end-point, and then on the other, until the line of sight passes along its axis to both of them. The question is, which of these two methods is to be preferred? It is easy to see that the first entails more time and trouble than the second; but two other methods are proposed as still more suitable for the object in view. Both of these depend on angular measurements, and in both two conditions are essential: the point C (fig. 1) must lie as close as possible to the line AB, and in addition, its distance from both A and B must be known approximately. In the first method, the instrument being set up at A, the angle a between B and C is measured, when $b=AC$ being known, the distance $h = DC$ of the point C from AB can be calculated by the formula

$$h = B \sin. a;$$

measuring this amount off from C the intermediate point D in the line AB is found.

In the second method, the instrument is set up at C itself, and the angle BCA, or its supplement γ measured, when h is found by the formula

$$h = \frac{a\,b}{a+b} \cdot \sin. \gamma$$

this amount, measured from C giving D as before.

These two methods are evidently superior to the two first-mentioned ones, and are, in addition, far more accurate; the last method, by angular measurement, giving under equal conditions the best results. It is also to be preferred when the lengths a and b have been incorrectly taken, for the closer C is to the line AB the less influence has such inaccuracy upon the mean error in h, since if $h = 0.2$ meter, the point D will be fixed, generally speaking, with an error of less than 2 millimeters, which in most practical cases would be unimportant.

The foregoing considerations are illustrated by reference to the Grossenhain base-line in the Saxony triangulation. The two ends, Raschutz and Quersa, were nearly 8,910 meters apart, and an intermediate point was required about midway between them. The angle from this point between the two ends was observed ten times, the mean value being about 179° 59′ 59.58″, with a probable error of ± 0.48″, the angle γ (fig. 1) being therefore fixed to 0.42″ ± 0.49″. The sides a and b could not be directly measured, though an approximation to their lengths was obtained by the plain table. By the distances, as thus assumed, h was found to be 4.62 millimeters, with a probable error of ± 5.39 millimeters. The actual base measurement subsequently gave the value of h as 4.52 millimeters, or only 1-10 millimeter shorter than by the assumed measurements, which, as compared with the mean error in h, is not worth consideration.

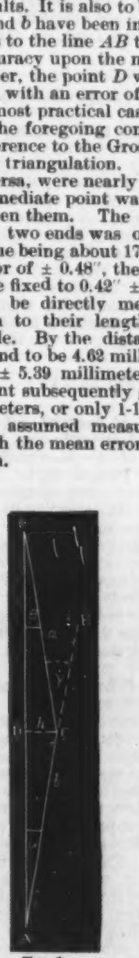

FIG. 1.

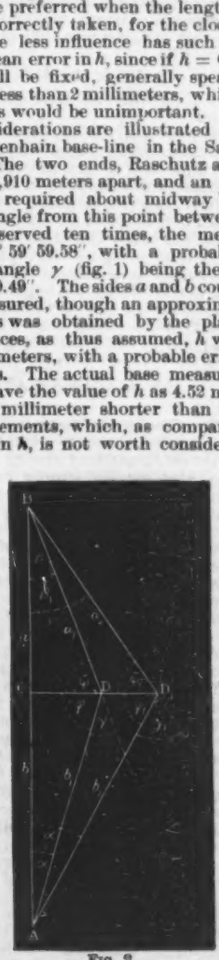

FIG. 2.
A = Kuhberg; B = Kapellenberg; C = Lottengrün.

2. *When the View Between the Two Ends is Interrupted.*—In this case, the fixing is much more troublesome, and two instances are given, differing in their conditions.

In the first, the view from Kuhberg to Kapellenberg, a distance of nearly 46,000 meters, was obstructed by a wood near the village of Lottengrün, through which, consequently, a clearing had to be cut. Before attempting this, however, calculations had to be first made whether the line of sight would cut below the ground at the required part or pass over it. These are given at length, and being satisfactory, the site of the clearing itself had then to be fixed. A simple angular measurement from a point close to the required site was however, impossible, on account of the high wood. Kuhberg and Kapellenberg could only be seen from a point west of the wood, at least ¼ kilometer

* From proceedings of the Institution of Civil Engineers.

distant from the proposed clearing; moreover, the distance of this point from each end of the line could not (as in the last case) be found with sufficient accuracy, so observations had to be made from two stations, whose distance apart could be measured. With a theodolite at D (fig. 2), close to the edge of the wood, the angle ADB was twenty times observed; and from its mean value and the approximate distance of D from A and B (as given on the Staff map), the angles φ and ψ were calculated in order to find the direction of the perpendicular DC. This line was then produced to D_1, from which point the angle $A\ D_1B$ was also twenty times observed, the distance $D\ D_1$ being accurately measured. The length of the perpendicular D_1C and its direction were next calculated, and the intermediate point C thus found, at which, by setting off the right angle $D_1\ C\ B$, the direction of the required clearing was laid off toward B and afterward extended toward A. Had the distance of D from A and B been known with sufficient accuracy, the second station D_1 might have been avoided. A special calculation proved that the error in φ and ψ, consequent on $A\ C$ and $B\ C$ being incorrectly known, would average about 22″; and if this clearing was 500 meters long, its far end would lie

$$500 \times \text{sin. } 22'' = 0.055 \text{ meter}$$

out of position, an error quite inappreciable in this case.

The second instance referred to a clearing over the Schneeberg ridges (which were densely covered with pines of fifteen to twenty years' growth), and differed from the first in that the line of sight between Kapellenberg and Ochsenkopf was found, after considerable trouble, to cut the ground about 2 meters below the highest point of this ridge. A very interesting account is given of the difficulties encountered in determining the site of this clearing and in fixing the heghts of the pillars upon the Kapellenberg and Ochsenkopf, in order that the observations might cross 2 meters above the highest point of the Schneeberg ridge. E. H. C.

AN ACCIDENT AT CINCINNATI.

The Cincinnati *Commercial*, of June 30 and July 1, contains accounts of the destruction, at 10:30 p. m. on June 29, of the new steel water tank for the high-service supply on Price's Hill. The tank had been in process of construction for more than three years. It was built on a foundation of solid masonry, and was situated about one-third of a mile northwest of the Price's Hill Inclined Plane. It was only completed so as to be ready for use about two weeks ago, and had never been entirely filled. It was 100 ft. in diameter and 40 ft. in height. Its capacity when full would have been 2,700,000 gallons, and at the time of the break it was estimated that it contained 2,242,000 gallons.

The tank was constructed of half-inch steel at the bottom and one-fourth inch at the top. The bottom was fastened to the solid masonry foundation by Ts or clamps, four in number, These clamps were about three or four inches in length from the angle, the upper portion being riveted in the tank and the lower to the bottom, which in its turn had been fastened to the foundation. It was naturally supposed that until the tank had been completely filled there would not be any considerable pressure. This theory, however, unfortunately proved not to be the cause. With the water less than 8 feet from the top of the tank, the clamps or Ts gave way, and in a second the huge concern was whirling down the embankment, while the water poured in torrents down the ravines, steep hillsides and still steeper roads.

When the tank left its moorings and tumbled over toward Glenway avenue, the water rushed heaviest toward Consodine avenue, and thence by ravines and cuts and roads to the Mt. Hope road, where there seemed to be for a time a miniature "mad" river. Along the Mt. Hope road stones weighing fifty to one hundred pounds were torn from position and thrown up alongside of fences. Small trees were uprooted, and the plank sidewalk for a distance of four or five squares was torn up and carried away.

THE GREAT DAMAGE

seemed to fall on the property on Consadine avenue, to which part of the hill the water seemed to rush first. Another large portion ran toward Glenway avenue, while what was left found its level through other channels.

DAMAGE TO PROPERTY.

One of the first buildings to catch the flood was the residence of P. J. Hogan, formerly a Police Commissioner of Cincinnati. It was a two-story frame, and shaken from its foundations somewhat, but was not damaged so as to require any extensive repairs.

Mr. Hogan happened to be in an outhouse at the time and fell into the vault. His cries brought assistance and he was rescued, more scared than hurt. Superintendent Moore says that the "burst" took place in the middle of the tank facing Consadine avenue, at a point three rings from the bottom, which would be 12 ft. up, and that a hole was torn out 48 ft. long and 24 ft. wide, leaving 12 ft. of the circle above the rupture remaining. This huge mass was thrown 75 ft. from the tank across the ground, carrying in its fall a heap of hammered limestone to be used as a wall around the lot, and thrown into the deep cut of Consadine avenue.

All the rest of the enormous mass was floated north and carried down the steep declivity and deposited in a completely flattened-out shape in Purcell avenue on the west, and Glenway avenue on the north, thus forming an irregular angle in the right angle formed by the intersection of those unfinished streets. All the portions of the tank which are visible present the outer side.

All around the circle of the bottom the thick steel plates were torn off all the way round as if they had been rotten cloth, the ragged edges of the severed metal presenting that sort of a torn appearance.

The tank was constructed after the designs of the late James E. Bell, superintendent of the waterworks. The city built the foundation of masonry, which was supervised by Col. A. L. Anderson, and has not given way. For the superstructure, the specifications were as follows:

The tank to be composed of twelve (12) rings of the best quality of fibrous boiler iron plates of a tensile strength of 60,000 pounds to the square inch.

The annexed tables give the required thickness and weight of iron in pounds per square foot, and also the number, length, width and area for all the plates for the bottom of tank and for each ring in the circumference of the tank.

The length, width and area of the plates given in the before-mentioned tables, includes the width of laps for the different sizes of rivets, to be used for joining the plates.

In the weight of iron given in the table, no variations will be permitted of more than two and one-half (2½) per cent. below standard weight.

All the rivets to be used for joining the plates must be what is termed "rose-head" rivets.

All the vertical joints in the first six (6) rings of plates, from the bottom upward, to be double riveted, known as "staggered" riveting, the remainder of the six (6) vertical joints, as well as the horizontal joints and the joints in the bottom of the tank, to be riveted with a single row of rivets.

The diameter, length and pitch of rivets, corresponding to the thickness of plates and width of laps for joints, are given in the annexed Table No. 3.

A rim of "channel" angle iron, $6 \times 5 \times \frac{3}{4}$ in thickness will have to be riveted to the bottom and side plates, on the outside of the tank, as shown in the working drawing. The same to be double riveted to the bottom and single riveted to the sides plates, with rivets 1 in. in diameter and 2⅞ in. long, spaced 2 in. apart from center to center.

An angle-iron flange, $4 \times 3\frac{1}{2} \times \frac{1}{2}$ in thickness, is to be riveted to the top edge of the uppermost ring inside the tank, with rivets 1 in. in diameter and 1⅞ in. long, spaced 6 in. apart from center to center.

In order to stiffen the tank, T-iron bars, $4 \times 4 \times \frac{1}{2}$ in thickness will have to be riveted vertically, inside to the side of the tank, with rivets 1 in. in diameter, 1⅞ in. long, spaced 6 in. apart from center to center, as shown in the working drawing.

Two angle-iron flanges, $2\frac{1}{2} \times 2\frac{1}{2} \times 5\text{-}16$ in thickness are to be riveted to the center plate and bottom of the tank as shown in the working drawings, with rivets 1 in. diameter and 2⅛ long, spaced 2 in. apart from center to center.

In the bottom of the tank above the chamber, three openings of twenty-two inches in diameter each will have to be made, to pass the pipes through, and in the side of the tank at the lower ring of plates, two manholes of an elliptic shape, and of the usual size (16″x24″) with frames, flanges and caps will be required.

The total estimated weight of iron plates, rivets and angle-iron for the tank amounts to 383,558 pounds, or 193¼ tons of 2,000 pounds.

As the work progresses, the plates to receive a good coat of suitable paint, both inside and out, to protect them from rust, and after the whole tank is completed to receive another good coat of plastic plate paint.

Bids were advertised for, and the following were received:

D. W. Carroll & Co., Pittsburgh	$29,950.00
Tudor Boiler Manufacturing Co., Cincinnati	35,640.00
D. W. C. Carroll (alternative proposition)	35,400.00
Ritter & Conly, Pittsburgh	31,000.00
Motherwell Iron Co., Lancaster, O	23,313.41
C. T. Dumont, Cincinnati	28,800.00
Cincinnati Stationary Engine and Hydraulic Works	31,520.00
Arthur G. Moore, Cincinnati	26,360.00
George Stacey & Co., Cincinnati	25,276.90

Mr. Moore's bid read as follows:

"I will contract to furnish the proposed tank of the dimensions, in the manner and on the conditions required, on the following terms: 6⅞ cents per pound, or to complete the entire tank in accordance with the specifications for the sum of $26,360, and furnish a tensile strength of 65,000 pounds to the square inch if required."

Mr. Moore proposed to use ingot iron or steel plates at a greater tensile strength than the specifications called for, but his bid was thrown out as informal, because it did not happen to include the obligation to furnish a sample and test.

He subsequently sent a communication in to the Board, showing why the award should have been made to him, and he had a lively sort of a wordy "set-to" with Mr. Foote on the subject, but without effect.

On the 22d of January, 1879, Superintendent Bell reported the bids, with the following recommendation:

I have examined the different samples of materials that the various contractors propose to use in the construction of the tank, and would report that the firm of Messrs. George Stacey & Co. furnished the best samples, which are in every respect equal to the quality called for by the specifications. Respectfully yours, JAS. E. BELL.

Before the contract was entered into Messrs. Stacey agreed that in event of the abandonment of the vertical T irons in the tank, they would agree to put in the vertical joints of the side sheets without extra charge.

The above recommendation was approved February 8, 1879, and the contract was entered into accordingly. On the 25th of February the contract and bond of George Stacey & Co. were approved.

DEVIATIONS.

The following notes of deviations from the specifications have been handed in for publication, in justice to the late Superintendent Bell:

First—The specifications provided that the angle iron to which the lower or first ring was riveted should be on the outside, for the obvious and twofold reasons of bracing and staying. Instead of this it was riveted on the inside, which produced one of the causes of rupture.

Second—The specifications required vertical stiffening bars from bottom to top. These were not put in.

Third—The contractors were allowed to use the drift to bring the rivet holes to the proper position, and the evidence of the misuse of this tool, and the principal cause of the disaster, is the numerous fractures it caused.

Fourth—It was Mr. Bell's intention to further strengthen the tank by hog chains radiating from a center plate, riveted to bottom of tank. The plans at the water-works will vouchsafe this statement.

Fifth—By bad inspection a number of the largest rivet-heads were passed when they should have been condemned because they were not "driven home." To cover up the defect the cracks were puttied up.

Sixth—It can be proven that a number of parties of mechanical reputation ridiculed the sizes of iron plates as being too large, and of unnecessary strength, and consequent increased expense, and some of these knowing ones went so far as to protest to the Board; and to satisfy the clamor the factor of safety was kept down to as low a point as was consistent, and if Mr. Bell had been spared to carry out his plans the disaster would not have occurred.

For the benefit of the public it may be stated that Mr. Bell died before the construction of the tank was commenced, the construction being done under Mr. Warden's supervision.

On Nov. 26, 1879, the City Commissioners changed the specifications, and, upon the recommendation of Superintendent Bell, a supplementary contract was made with Stacey & Co. "to change the three upper courses or rings to form the tank at their bid of $1,500."

On the 2d of December, 1879, a supplementary

contract was entered into with Stacey & Co. by the City Commissioners as follows:

First—All iron used must be of a tensile strength of 65,000 pounds to the square inch, and equal in every respect to the sample furnished.

Second—Instead of the T-iron bars, provided in the specifications, the contractors must, without extra charge, butt the vertical joints of the tank with "cover strips" of the same material and thickness as the plates, double riveted in the manner described.

When the Board of Public Works was restored, the present Superintendent of Water-works, Mr. Arthur G. Moore, took the superintendency of the tank construction, and on the 28th of April, 1880, he recommended it as "necessary to girder the upper ring courses of the tank, in order to enable them to properly resist the violent storms," and an agreement was entered into with Stacey & Co. to perform this extra work at their bid of $2255.

The city expended on the tank up to January 1, 1881, a total of $58,603.41, which is itemized as follows: Ground rent on the place, $3,600; property on Glenway avenue, $3,000; improving Consadine place, $12,943.10; foundations for tank, $9,610; Stacy's tank contract, $26,508.32; valves and connections, $1,025.66; new boilers, $820.98.

PERIODICAL MOVEMENTS OF THE GROUND AS INDICATED BY SPIRIT-LEVELS.*

BY M. PLANTAMOUR.

This paper narrates the experiences of a second year's continuous observations from 1st October, 1879, to 30th September, 1880. The levels were arranged as before, but readings were only taken twice a day, at 9 a. m. and 6 p. m., the first a little after the minimum, the second rather before the maximum, diurnal movement; the mean of these represented the bubble-position for that day. The curve-trace was also modified so that it might indicate the ground movements directly in seconds of arc, instead of in millimeters of the bubble-scale.

I. *The Level Placed East and West.*—From the middle of November the east end fell rapidly, and toward the end of that month and up to December 26 in a most marked and unexpected manner, until such depression amounted to —88.71 seconds. It then rose 6.55 seconds up to January 5, to fall again and gradually reach (on January 28) the minimum for the year, viz., —89.95 seconds. After this date it rose slowly, though, as compared with the preceding year, very gradually, following in general the daily rise and fall of the temperature. The total amplitude of the oscillation from October 4, 1879, to January 28, 1880, was 95.80 seconds against only 28.08 seconds the previous year.

Two facts in this curve are most noticeable, as proving that these ground movements are partly due to some other unknown factor than the external temperature. 1st. The extraordinary depression from the end of November to the end of January, which certainly was not caused by any great absolute lowering of the temperature. 2d. The very insignificant elevation during this summer as compared with the previous one, and this in spite of the greater heat of this summer, especially of the last half of July.

II. *The Level Placed in the Meridian.*—This has not been influenced by the exceptional cold of the winter, and its oscillations present a striking resemblance to those of the first year, the total amplitude for the year being 4.56 seconds as against 4.69 seconds in 1878-79. The curve-trace throughout the year has been below the starting-point of 1878, but this arises from the readings having commenced that year on December 23 instead of on October 1. This year's curve repeats the still unexplained fact that the oscillations of the south end act in a *contrary direction* to the temperature from April to October—a fact which does not occur in the case of the level placed east and west.

In reply to criticisms, the author considers that neither of these oscillations can be due to any movements of the outside west wall of the house against which the masonry table is backed, because in the spring and summer of 1878 the levels were placed directly upon the ground in the middle of the cellar, and their indications were then sensibly greater than those observed during the same season in two consecutive years upon the masonry table. E. H. C.

NOTE.—M. Plantamour suggests whether there can be any possible relation between the great depression of the east end and the earthquakes which occurred about that time.

*From the proceedings of the Institution of Civil Engineers.

MINNESOTA SURVEYS.

DEAR SIR: We would ask your co-operation in the organization of a Minnesota Association of Surveyors and Engineers, similar to those at work in other States. We would include in this call all who are engaged or particularly interested in land surveying, as well as those in other branches of engineering, who are interested and in sympathy with our aims and willing to aid us with their counsel. We do not assume to represent the profession of civil engineers and surveyors of the State, but as having the welfare of our profession at heart and desiring to promote its interests and the interests of its patrons. We believe there is urgent need of greater uniformity in our methods of practice, and that through organization and the interchange of ideas which will follow that this result may be attained. We all know that our State law with reference to surveyors is grossly inadequate, and that the office of County Surveyor might as well be abolished as to remain as the statutes now leave it. We believe that legislation is also needed looking to the preserving and perpetuation of the government corners which are rapidly disappearing. Collectively we can determine what we want and what the public good demands in the way of legislation and then do much toward securing this legislation. Singly we can do nothing. The discussions in our legislature the past winter upon the Bookwalter bill—"to provide a better system of land surveys in this State"—has awakened an interest, and while the bill failed by a few votes it had the hearty support of the ablest members

At the next session, we can, if united secure the enactment of such a law as will be just to the surveyor and protect the public from incompetency and criminal carelessness in the practice of surveying. We have vexed questions arising in our practice and in these we can aid each other. We submit whether the decisions of the courts on questions of boundary should not be compiled and in our hands for reference. We believe that united action of the profession is demanded and can but result in benefits to us all, professionally and financially. To that end we invite you to attend with us and take part in a meeting at Minneapolis, at Geo. W. Cooley's office, 411 Nicollet ave., to begin on Wednesday, Sept. 7, 1881, at 2 o'clock p. m. This place and date have been chosen to secure the special railroad rates which will doubtless then be offered on account of the Fair. Business will begin promptly at the hour named and such action taken toward organization as those present may determine.

Parties receiving this circular are urged to notify surveyors and engineers of their acquaintance of this movement, as our list is incomplete. Let us have as full an attendance at our meeting as possible.

GEO. W. COOLEY, Civil Engineer and Surveyor, 411 Nicollet avenue, Minneapolis.
W. G. KELLAR, Civil Engineer, Albert Lea.
A. MOTZFELDT, County Surveyor, Albert Lea.
JOHN ABERCROMBIE, County Sur., Alexandria.
T. W. RUNDLETT, City Engineer, St. Paul.
F. E. PRATT, Civil Engineer, Anoka.
JOHN P. MUMFORD, Civil Engineer, Morris.
J. B. SALISBURY, Civil Engineer, Litchfield.
M. B. HAYNES, City Engineer, Mankato.
JAMES JENKS, County Surveyor, Clearwater.
D. T. WHEATON, County Surveyor, Morris.

MASSACRE OF AMERICAN SURVEYORS.

SANTA FE, N. M., July 6.—No particulars have been received regarding the massacre of thirteen of a party of American surveyors of the Mexican Central Railroad Company, forty miles south of El Paso. The surveying party was under the charge of Locating Engineer C. Mephane, a native of Illinois, and Engineer M. J. Cunningham. Mr. George X. Anthony, General Manager of the Mexico Central Railroad, who is at Paso del Norte, was at once informed, and armed parties were immediately dispatched to the scene of the massacre. So far none of the names of the killed have been learned. It is not positively known whether the raid was made by Indians or Mexicans, but it is supposed some of Victoria's war chiefs and right-hand men, who with about thirty warriors escaped from the Tres Castillos fight, are the perpetrators.

The Cincinnati Southern fairly opened for through business July 1, 1880. Of the freight earnings $692,-993.12 was for through freight, and $754,555.99 was for local. For six months ending July 1, 1881, the total gross earnings aggregated $1,005,318.95, and the gross earnings for 1881 are estimated at $2,400,000.

NOTES.

CLEANING OUT LIME-INCRUSTED WATER PIPES.

One of our correspondents writes: "As a sort of 'shop kink' I give you a curious experiment tried on an engine water-supply pipe that had become choked up with lime incrustation. After hammering it for an hour or two and kindling a fire all over it, without any result, one end was plugged up, and about a pint of refined coal oil was poured in the other end—all it would hold—leaving it stand all night. The next morning the entire mass slid out, a solid lime core. Before trying this we thought of throwing the pipe away as useless, and getting a new one."—*American Machinist.*

HEATING EFFECTS DUE TO COMPRESSION.

On two former occasions we have taken notice of the results of certain experimental investigations instituted by Professor P. G. Tait, of the University of Edinburgh, in regard to the thermometers used in the Challenger expedition, and the alleged effects of compression upon them when immersed to great depths in the sea. Still pursuing the line of inquiry suggested by the experiments made with these thermometers, the learned professor has since made a further series of experiments on the heating effects of compression of a number of liquids and semi-solid liquids, the results of which he laid before the Royal Society of Edinburgh on the evening of Monday, the 16th instant. He mentioned that he had employed a ton pressure upon each of a number of different substances, and had noticed in each case the rise of temperature due to the compression exerted. Marine glue gave a rise of temperature to the extent of 0.9° Fahr.; raw potato, 0.7°; pith, 0.37°; cork, 1.3°; a piece of bar soap, about 1-20°; a piece of liquorice and a piece of cheese, about ¾°; a piece of raw flesh behaved very much like the potato; india-rubber and solid paraffin rose in temperature about 1½°; lithographers' ink and shoemakers' and bees' wax, about 1.4°; lard, about 2°. After mentioning these details, Professor Tait said it was remarkable that potato and raw flesh, with so large a percentage composition of water, had a large comparative amount of independent heat produced, while pith gave no perceptible difference of effect over what would have been produced by water alone. Cork has this peculiarity, namely, that when the pressure was removed the fall of heat was only 0.9° Fahr., as against 1.3° of a rise on the application of the same amount of pressure. That seemed to agree, he said, with what was already known of cork, namely, that on the removal of the pressure it did not spring back to its original form. In these respects india-rubber was opposed to cork, which had this further peculiarity, that, on continued experiment, the amount of heat produced by the pressure gradually fell till it was the same as the amount of cooling which resulted on the relaxation of the pressure. About shoemakers' wax there was the peculiarity that it took a very long time before the heating effect was fully produced. Its chemical composition, also, was of course different from that of bees' wax, which yet had precisely the same amount of heat produced. In concluding his interesting communication, Professor Tait intimated that further research would be necessary before they could get definite facts showing the exact heating effects of compression, which, he added, would form the subject of a future communication.—*Engineering.*

THE ELECTRIC CONDUCTIVITY OF HEATED GASES.

Gases are generally considered incapable of conveying the current from a battery of only a few elements, though the spark from a powerful battery is known to traverse them. In 1853, however, M. Edmund Becquerel discovered that when brought to a red heat a gas would conduct the current of even a single Bunsen element. But he found that the conductivity did not follow the law of Ohm, which holds for solids and apparently for liquids. It depended on the intensity of the current, the number of cells in the battery, and, between two electrodes with unequal surfaces, on the direction of the current. These results have recently been questioned by Herr G. Weidemann, but M. Blondlot has vindicated the accuracy of Becquerel's conclusion by forming a circuit of a single Daniell cell and a Lipmann capillary electrometer, interrupted at one point by two platinum disk electrodes kept nearly ½ in. apart in air. When the passive state of the electrometer indicated that no current flowed in the circuit, owing to the breach caused by the non-conducting air, M. Blondlot heated the platinum disks red hot by means of an enameller's blow-pipe, and the electrometer then indicated a strong current in the circuit. Consequently the

continuity of the circuit, which was broken by the cold air, was established by the hot air. M. Blondlot finds, moreover, that the air need not be so highly heated to make it conduct as Becquerel supposed. A gas flame placed at a distance of 40 centimeters (about 16 in.) from the platinum disks will permit the passage of the current from 5 Bunsen elements; the mean temperature of the gas being from 60 deg. to 70 deg. C. It follows that warm atmospheric air is a partial conductor, and hence, perhaps, one reason for the prevalence of lightning discharges in the summer months.

THE PITTSBURGH SUSPENSION BRIDGE.

The suspension bridge connecting Pittsburgh and Allegheny, which was partially destroyed by fire recently, was a structure of some importance in the history of bridges. The suspension bridge, which replaced an old covered wooden structure, was finished in 1860, and was considered the finest in the world. The builder, Roebling, had not then acquired the European celebrity which came from the erection of the Cincinnati and Covington bridge. Mr. Roebling had a *carte blanche* to do as he saw fit, though he submitted all his projects to the company as he went along, and they were all indorsed. So perfect was the work considered that when the Prince of Wales and suite were here they were astonished to find such a work of art in what was then a rather small provincial town. The Duke of Newcastle, who was a very practical man, scrutinized the bridge closely, and informed the Prince that it was the best bridge he had ever seen. Before the war a dollar went a long way; what cost $300,000 then would cost $500,000 now. Roebling, the builder, when asked what was the strength of the bridge, said he had ascertained the power of the greatest hurricane that ever passed over Pittsburgh prior to 1858, and multiplied this by nine, which represented the strength of the bridge. President Harper says such power gave the company sufficient confidence in the power of the structure to resist pressure that no insurance against flood damage was considered necessary, especially as the bridge had been put 5 feet above the flood mark of 1832. It was considered almost impossible to set the bridge on fire, so since 1859 it has carried no insurance of any kind, and the company not only must stand the loss of several weeks' wagon travel, but must repair the damage themselves out of their accumulations.

CROSSING THE ENGLISH CHANNEL.

ANOTHER scheme for crossing the English Channel by railway has just appeared. The originator is Mr. Bradford Leslie, the engineer of the East India Railway Company, who boldly proposes to travel into France through a cylindrical steel tube submerged 40 feet below the surface of the water. The tube would be so ballasted as to make it weigh 1¼ tons to the foot less than the water displaced, its buoyancy being counter-balanced by moorings at every 250 feet. At the shore ends it would be laid in dredged or excavated channels, and would be made to rise from the mid-channel depths by easy gradients. The cost of carrying out this scheme is estimated at £8,000,000.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

Governor Cornell has vetoed the bill authorizing the construction of a new aqueduct for New York's water supply. The Governor says: "The particular object of this bill is to authorize the construction of an additional aqueduct for the conveyance of water from the Croton dam to the city of New York. The engineers of the Croton Water Bureau frankly state that the purpose is to construct a new and independent aqueduct of more than double the capacity of the present one; while no very definite statement has been made as to the anticipated cost of the new work, the engineers admit a probable cost of or at least $12,000,000. Comptroller Campbell's expresses the opinion that the proposed work will cost at least $15,000,000. Confessedly, therefore, the bill under consideration must be treated as a proposition to increase very largely the permanent debt of the city for the purpose set forth. The public debt of the city of New York, exclusive of the accumulated sinking fund amounts at the present time to about $100,000,000, with a net annual interest charge of nearly $7,000,000. No enlargement of this great debt should be permitted except under the most pressing and unavoidable necessity. On the contrary every possible effort should be exerted to reduce and extinguish it as speedily as practicable. This is demanded as a vital condition to the future growth and continued supremacy of our great metropolis, whose burden of municipal taxation, more than all else, endangers and retards her prosperous development. What, then, is the emergency to meet which it is now proposed to augment the present liability of the city? It is alleged that an additional supply of water is imperatively needed, and this too, when ninety-three gallons per capita are daily furnished. Nobody will pretend that any community can properly use one-half of that amount. The only inference to be reasonably deduced is that a large proportion of this great volume of water is worse than wasted. In the event even of satisfactory proof of an indispensable necessity for a new aqueduct, some consideration must be given to the financial aspect of the case. The constitution says: 'It shall be the duty of the legislature to provide for the incorporation of cities and villages and to restrict their power of taxation, assessment, borrowing money, contracting debts and loaning their credit so as to prevent abuses in assessments and in contracting debt by such municipal corporations. In the face of this imperative injunction the legislature has provided in the accompanying bill for an increase of the permanent debt of the city of New York, limited only as in the judgment and pleasure of the Commissioner of Public Works may seem best. Instead, therefore, of observing the positive command of the constitution to restrict the city of New York in contracting indebtedness, the legislature would by this bill place it within the power of one single official to increase the permanent debt thereof to whatever sum he might see fit.

An officer of the Public Works Department pointed out to a reporter one or two erroneous statements made in the Governor's veto. Said the officer: "The Governor claims that the present supply of water is 93 gallons per day for each person in the city. Now, the daily consumption averages over 90,000,000 gallons, and sometimes nearly 100,000,000. The aqueduct conveys about 93,000,000 gallons and there is a population of 1,200,000. In addition, there is a large floating population, and water is now used in immense quantities by manufacturers. Commissioner Campbell reduced the water rates last year for the purpose of bringing manufacturers to the city, and his policy had the effect intended. The attraction of manufacturers to the city must, as a matter of course, result in increasing the city's revenue. Without a new aqueduct, these interests will eventually have to remove from the city." "The Governor says, in effect, that he cannot understand why there should be a scarcity of water," said the reporter. "But you cannot get away from the fact that below Eighth street, or about that line, water is not brought to the second floors of buildings. Outside of inconveniences, this means the spread of disease. One point more. Suppose an accident should happen to the aqueduct, what would the condition of New York be? I can show you places all along the line of the aqueduct where water is escaping in streams as thick as your arm. Of course we make our repairs as quickly as possible, but the breaks are occurring continually. As a matter of safety alone, a new aqueduct is needed."

RAILROADS.

A new trust company has been formed in Boston to be called the American Loan and Trust Company.

The Quincy, Missouri & Pacific branch of the Wabash Railroad was completed July 1 to Trenton, Mo., 140 miles west from Quincy, Ill.

The Staten Island North & South Shore Railroad Company have filed articles of incorporation at Albany. The capital is fixed at $200,000.

The Texas and Louisiana Railroad also filed a charter. Capital stock placed at $5,000,000, and the line to extend from Sherman to Mount Pleasant, Titus County.

The Fort Worth & Rio Grande Railway also filed a charter. Capital stock placed at $300,000, and the road will extend from Fort Worth to Brownwood, Brown County.

The directors of the Ontonagon and Brule River Railroad visited Ontonagon last week and put the first twenty miles of the road under contract. The work of grading will begin July 5.

The engineers of the Tampa, Peace Creek & St. Johns River Railroad, in Florida, are at work locating between Tampa and Peace Creek, on the Alofia River. This railroad is being surveyed by Chicago capitalists.

A new short line of railway is projected between Wooster, O., and Russell, O., to secure connection for Wooster people with the New York, Pennsylvania & Ohio and Cleveland, Tuscarawas & Wheeling railways at Russell.

The Iowa Northwestern Railway Company, with headquarters at Algona, has been incorporated. The object is the construction of a railroad across the State. The capital is fixed at $5,000,000, and Peter Meyer, S. R. Williams and H. Durand are the incorporators.

The Lake Okeechobee Drainage & Canal Co., represented by Messrs. Linderman & Coryell, have had a party of engineers at work running levels from Lake Okechobee to St. Lucie River. They are reported to have four dredges at work cutting canals to drain the lake.

The St. Louis, Fort Scott & Wichita Railroad was completed from Fort Scott to Iola June 30, a distance of forty-eight miles: $49,000 township bonds have been voted in Woodson County, and the road located as far as Yates Center. Work on the extension will begin at once.

The Chicago & Atlantic Railroad Company has left with the Recorder of Wabash County, Ind., a mortgage on its railroad and equipment to the Farmers' Loan and Trust Company, of New York. The mortgage is for $6,500,000. Grading on this line is progressing at Laketown, Wabash County.

The Sabine Pass & Texas Northern Railway filed a charter in the office of the Secretary of State of Texas July 3. The capital stock is placed at $3,000,000, and the proposed line extends from Marshall to Sabine Pass. H. W. Twombly, R. H. Parker, W. B. Hotchkiss, New York, and R. A. Abbott, Waukeegan, Ill., are among the directors.

Messrs. Wells, Harrison & Schulte, the railway contractors, signed the contract for grading fifty miles of the Northwestern's Iowa extension, in addition to that already under way at Milwaukee, June 29. The extension runs from the present terminus at Sioux Rapids, on the Tomah and Northwestern Division, to Orange, on the St. Paul & Sioux City road.

WILKESBARRE, Pa., July 6.—The North & West Branch Railroad was sold at sheriff's sale at Bloomsburg to-day to Chas. Parrish, of this city, for $700,000. The road is almost graded from Catawissa to Nanticoke. A new company is to be organized at once and the road completed. This will make a rail outlet from the mines of the Pennsylvania Railroad at Nanticoke.

Articles of incorporation of the Mississippi & Western Railway Company were filed at Des Moines, Ia., on Saturday. It is the intention of the company to build one or more lines of railway across the State from the river westward, with branches. The articles of incorporation give the company the power to construct and use barges and boats for the transportation of freight.

DENVER, Col., July 6.—The Denver & Rio Grande Railway Company has contracted for the grading of its short line from a point on its main line seventeen miles south of Denver to the South Fork of the Platte River on a water grade, and for the extension from Denver to Fairplay and the valley of the Arkansas River. A large force is being put on the work, which is to be pushed vigorously.

By a despatch from S. B. McKee, locating engineer on the Ontonagon & Brule River Railroad, we learn that the Michigan & Wisconsin Railroad Co. has assumed the construction of the above road as a continuation of their line through the Lake Superior copper region to Ontonagon, 20 miles, to be completed by December 1, contractor to begin work July 1; P. S. Woodard, engineer on construction.

The Western extension of the Northern Pacific was completed to Glendive, on the Yellowstone, on Saturday evening. Beyond Glendive to Miles City the roadbed has been graded and some sixty thousand ties, which have been prepared in the vicinity, are being distributed over the road. Work is also progressing favorably beyond Miles City. The cars will be running to Glendive in a few days after the road is completed.

A Sioux City dispatch says: "The new railroad company organized at Lincoln, Neb., to build a road to Fremont, under the name of the Lincoln & Fremont Railroad, is reliably reported to be backed by the Union Pacific, Sioux City & Pacific, and Chicago, St. Paul, Minneapolis & Omaha companies. These three corporations will join in the use of this road, which is to be finished within ten months if the local aid promised is put up.

Contracts have been entered into for the completion of the Connotton Valley & Straitsville Railroad from Canton to Coshocton, a distance of sixty miles, within three months from the 22d of June. The line from Coshocton to Zanesville is now being located and will be let during the present month. The purpose is to have this feeder of the Connotton Valley road, eighty-five miles long, in running order by December of this year. The Connotton Valley road opened on the 4th of July to Cleveland, by the Cleveland & Pittsburgh road from Bedford. It is expected that the twelve miles from Bedford to Cleveland will be in running order the last of this month.

July 2 articles of incorporation were filed at Peoria by the State Line Railway Company. The instrument provides that the road shall be constructed from a point in Iroquois County, on the line between the States of Illinois and Indiana, then extending westward through the counties of Iroquois, Ford, McLean, Tazewell, Peoria, Fulton, Knox, Warren and Henderson, to a point on the western boundary of the State, about opposite the city of Burlington. The capital stock will be $1,800,000, divided into 18,000 shares of $100 each. The incorporators are as follows: John L. Beveridge, Eugene Ellery, David B. Dewey, Robert Kendall, of Evanston, and A. Schraeder, of Chicago, who are to constitute the first Board of Directors.

The adjourned meeting of the provisional directors of the Ontario & Quebec Railway Company was held in Toronto, June 30, at which the following gentlemen were present: Hon. J. Rosaire Thibaudeau, Hon. P. Mitchell, Messrs. Duncan McIntyre, A. B. Chaffee, H. S. Howland, Adam Brown, E. O. Bickford, C. J. Campbell, J. Lockhart Gordon, E. B. Osler and Hector Cameron, M. P., and Mr. Lumsden, C. E., the chief engineer. The final subscription of $1,000,000 of capital stock was made, and $100,000, the first call thereon, deposited. The meeting for election of the permanent board was called for July 19 in Montreal, and the publication of the requisite two weeks' notices thereof was ordered. A conference was afterward held with Colonel Grey, Chairman of the great Western Railway Company of Canada, and Mr. Broughton, the general manager of that company, when arrangements were made for the hearty co-operation of that company in the scheme. Communications were also read from representatives of the Quebec Government road and other railways interested in the early completion of this most important link necessary for an independent through railroad system for Canada, expressing their desire for the success of the enterprise, which is now assured, as it is intended to prosecute the work of construction without delay.